THE

ELECTRICAL REVIEW.

VOL. XXX. JANUARY 1, 1892. No. 1

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TOWN FOGS AND THEIR EFFECTS.

DR. W. J. RUSSELL, F.R.S., has brought together some most interesting facts and figures concerning the nature and effects of town fogs, in his address to the members of the Hygienic Congress.

In speaking of the employment of artificial means of lighting, to dispel the darkness of a metropolitan fog, he gives the result of a calculation by Mr. Livesey, of the approximate cost of the undertaking. He says:—"If a dense fog covered the whole of London, and lasted all day, the additional amount of gas consumed would be 30 million cubic feet; but since so extensive a fog as this probably never exists, and certainly never lasts all day, the actual amount of gas consumed may be correctly reckoned at 25 million cubic feet; and if the cost of this be calculated at 2s. 6d. per 1,000 feet, which is rather below than above the actual cost, it amounts to £3,125. But, after all, it is not the single days of London fog that measure the extra amount of cost of artificial light, on account of fog; it is rather the continually occurring dull days and local transitory fogs which demand the extra supply of gas, and this is often 5 to 15 million cubic feet a day, and gives a total by the end of the winter which is very considerable. As a standard of comparison, I should state that the total consumption of gas in the London district in a day of 24 hours, during the depth of winter, is 140 million cubic feet."

Dr. Russell does not hold out much chance of the ultimate disappearance of fogs from our towns—nor, in the interests of artificial-lighting companies, do we wish him to do so—but he looks forward to a fog of a better colour, and containing a smaller percentage of the products of combustion.

In a series of ingenious and elaborate diagrams, he compares prevalence of fogs and fluctuations of temperature, with the death-rate in the locality. As might be expected, the fogs are nearly always preceded by a thermometric fall, and the one follows the other on his curves. Similarly the death-rate, in a rough sort of way, follows the curve of temperature. In comparing the death-rate with the indications of fog the agreement is not so conclusively marked, however; and Dr. Russell would appear to draw the inference that fog is not specially to be denounced with reference to health. It may, or may not be so, but we scarcely think deducements can be drawn from a diagrammatic representation of two variables such as fog and death. They are not sufficiently contemporaneous. In a few cases the death may happen at the same time as the fog, but in the majority of instances the bill is payable after an unknown period has elapsed.

Not the least instructive part of this paper was the following table, giving the latest analysis of the fog deposits taken from Kew and Chelsea respectively. An inspection of it shows at once the great preponderance of the products of combustion:—

	Chelsea. Per cent.		Kew. Per cent
Carbon	39·0	... ...	42·5
Hydrocarbons	12·3	... ...	4·8
Organic bases (pyridines, &c.)	2.0		
Sulphuric acid (SO_3)	4·3	... ...	4·0
Hydrochloric acid (HCl.)...	1·4	... ...	0·8
Ammonia	1·4	... ...	1·1
Metallic iron, and magnetic oxide of iron	2·6		
Mineral matter (chiefly silica and ferric oxide)	31·2	... ...	41·5
Water, not determined (say difference)...	5·8	... ...	5·3
	100·0		100·0

ELMORE COPPER.

THE accounts of Elmore's Patent Copper Depositing Company as presented to the shareholders are somewhat involved. We have summarised the balance-sheet as under :—

DR.	£ s. d.
Received from shareholders, borrowed on mortgage due to creditors, and royalties received in advance	199,116 13 10
Profit on sale of land and forfeited shares	6,058 7 0
Balance from profit and loss account	703 10 10
	£205,878 11 8

CR.	£ s. d.
Land, buildings, plant, machinery, debtors, stock in trade, fixtures, furniture and cash	113,222 5 2
Patents and Elmore Wire Company shares	92,656 6 6
	£205,878 11 8

The profit and loss account may be summarised thus :—

DR.	£ s. d.
Rent, directors' fees, salaries, stationery, &c.	4,426 11 9
Advertising, &c., travelling, maintenance of patents and plant	1,322 11 11
Income tax	103 12 3
	5,852 15 11
Balance	703 10 10
	£6,556 6 9

CR.	£ s. d.
Balance of factory account	1,398 17 6
Net amount of balance brought forward	2,919 8 3
Sale of licenses, interest, discount and transfer fees ...	2,238 1 0
	£6,556 6 9

It will be seen that the liabilities to shareholders and others amount to £199,000, and the tangible assets, at their full valuation, to £113,000. The remainder of the assets is composed of patents and Wire Company shares, the value of which have yet to be determined. As to the future prospects, the directors are sanguine. We have to consider the foundation upon which their confidence is based. That foundation is the estimate of the managing director, which is an absurdity. Its only advantage is that it affords an opportunity to print in large type such phrases as "over 33 per cent.," and with increased output (after increased capital) "over 50 per cent. per annum." Such an estimate on imaginary sales would be inexcusable at any time but is especially so when accompanying a second annual report issued six months' late. Whilst the directors take full advantage of the managing director's optimistic phraseology, careful reading shows that they do not express their own conclusions so much as set forth Mr. Elmore's. They "see no reason to doubt the conclusions therein contained;" not from any given details of business done; not from any knowledge of the earning powers proved to them in their directorial capacity, but because "the report takes no account of important sources of profit, such as sales of licenses, recovery of precious metals and special kinds of work." On most points the directors' language is non-committal. That various difficulties connected with the mechanical details have been successfully overcome is stated, not from the directors' knowledge, but the managing director reports it to them; that the surplus land may be sold at a profit of about 100 per cent. is not what the directors say, but what they are "advised." There are three direct statements by the directors—that they "have pleasure in submitting their report" (which is surprising), "much satisfaction in announcing the successful completion of the 20-ton plant" (one-fourth of it being announced as at work at the last meeting, nearly eighteen months ago), and, "in conclusion, to record their belief that . . . . the shareholders will find that in the Elmore invention they possess a process that will be a continued source of profit, increasing from year to year, as the quality of the goods produced becomes more and more known." As, earlier in their report, the directors saw no reason to doubt the conclusions of the managing director, the inference is that they record their belief that the 33 per cent. and the 50 per cent. profit will be increased as the years roll on. It is very much to be regretted that any board of directors should so word a report as to permit such an inference to be drawn with so little to support it. The paragraph is an elaboration of one in the report of Mr. Elmore, who says "that in the Elmore invention the company possesses a property not paralleled in the whole range of industrial investments"—a statement we believe to be strictly true.

It is impossible to peruse the directors' report without coming to the conclusion that it is a marvel of plausibility. Yet the plausibility is very easily attained. The first requisite is that someone should be found who would make exaggerated estimates which the directors could quote. For the rest, it is only necessary to have a short memory and to be able to turn inconvenient facts to convenient account. The "invention" is an Elmore invention, and was acquired from the Messrs. Elmore. It does not seem to the directors that any independent opinion would be advisable, or that the inventors would be likely to take too sanguine a view. When the company was formed it was said that the invention had gone through all the preliminary stages, and was ready for immediate commercial development. In their second annual report the directors say that delays have occurred on account of manufacturing difficulties which have now been overcome, and, besides, have been really good things, because they have led to the taking out of fresh patents which will prolong the "monopoly." No doubt the new patents are intended to be a set off to the overcoming at the shareholders' expense of difficulties which were supposed to have been overcome before the shareholders were asked to subscribe the capital. The delays are grandiloquently referred to as incidental to all "new discoveries." Our readers know how much of a discovery there is about the Elmore

process, and how new it is; but, no doubt, such language will convey to the untechnical shareholders the impression that they are the possessors of a most lucrative monopoly.

Apart from all technical questions whatever, it is surprising that business men should circulate such estimates as those of Mr. Elmore, supported by M. Sécretan, who "writes that already he sees the demand will enable the company (French) to double or even treble the plant within a short period." Directors' reports should afford less space to visionaires of this sort and find room for some statements of a more practical kind. We will suggest some. The 5-ton plant has been at work over a year. That gives an output of 250 tons, and, on Mr. Elmore's own estimate, a profit for the year of £12,612, sufficient with the amount brought forward to pay 10 per cent. dividend. Where is the dividend? The delays cannot account for everything, because the 5-ton plant was in going order at the time of the last meeting, and some work must have been done or it would not have been possible for the "high quality of the company's manufactures" to be so thoroughly determined. How much work has been done? How many tons of copper have gone into the works, and how many have gone out? What is the total value of the precious metals extracted? Such practical details are conspicuous by their absence. Their place is taken by imaginary figures and hollow phrases. Why? We think we can give the reason why. It is because the Elmore process was launched on imaginary figures and hollow phrases. It has lived on them for two years and a-half. How long it will continue to live on them time alone can tell.

The Elmore Wire Company seems to be a convenient source whence the parent company can draw supplies. It imprudently purchased a license for the manufacture of wire, and thereby enabled the parent company to pay a dividend of 50 per cent. It has now obtained another license "upon a moderate royalty" for the manufacture of copper sheet "outside the requirements of the parent company." It has been found that the sale of the copper sheet will be much more lucrative than the wire or spirals, and when this fact is properly recognised, it will be seen why we say that the wire license was imprudently purchased. We presume that the payment of royalties to the extent of £5,000 in advance is in consideration for the moderation of the royalty, which would perhaps have been less moderate, if the more usual method of payment when earned, had been adopted.

The land upon which the Wire Company's factory is built has been purchased from the parent company at nearly double the price paid for it by the sellers, who congratulate both parties on the very satisfactory bargain. If we remember rightly, the Wire Company was to commence operations before the completion of their factory, the parent company furnishing material in the meantime. The mechanical difficulties with the finished articles seem to have extended also to the tubes required for cutting up into spirals, since no mention is made in either company's report of the disposition of the product of any portion of the 5-ton plant for this purpose. As the wire and the spirals, which were to form the basis of the company's business, are now superseded, it is to be hoped that the terms of the license for copper sheet will prevent the parent company from extending its "requirements" so as to compete with its licensee.

Following is a summary of the Wire Company's balance-sheet:—

Dr.	£	s.	d.
Amount received from shareholders	182,556	5	0
Sundry creditors	8,301	19	11
	£190,858	4	11

Cr.			£	s.	d.
Land, buildings, plant, machinery, "investments," stock, furniture, debtors, and cash			76,779	0	0
Licenses			111,505	0	0
Administration expenses	5,268	5	5		
Less receipts from interest, investments, and transfer fees	2,694	0	6		
			2,574	4	11
			£190,858	4	11

It may be remarked that all the directors of the Wire Company are also directors of the parent company; that calls are in arrear to the amount of £12,751 5s., and that 1,360 shares, representing £2,720 (£452 10s. paid on them) have been forfeited. We congratulate the late holders of the forfeited shares.

In another column we give reports of the meetings of the two companies referred to above, from which we gather that the shareholders are apparently quite satisfied with the position and the prospects of their respective properties. As we have, from time to time, had occasion to remark, persistent efforts have been made to give prominence to Elmore shares, and to induce the public to purchase them. We are of opinion that the advice cannot be too strongly given to investors to wait until manufacturing profits have been realised, and not to be led away by imaginary estimates or plausible promises.

Fire Risks and Electric Lighting.

IN drawing attention to the letter of Messrs. Drake and Gorham, we wish to support their opening remark by asking those of our readers who are affected by the indecision apparently existing upon such an important subject to express their views on the situation. We had hoped that fire risks in electric lighting had been reduced to a point upon which everybody was agreed, but this letter seems to open up a new field for discussion.

Electric Welding.

MESSRS. LLOYD AND LLOYD appear to have brought electric welding to such perfection that it is likely to be largely employed in industrial operations. In hydraulic work combinations can be made which have hitherto been regarded as impossible. Electrically welded seams in iron and steel tubes are manifestly superior to those closed by gas, and in iron barrels for the conveyance of petroleum, in steel castings, in cutting and boring plates, girders, &c., where as much work can be done in one hour with the arc as in ten with a cold set, the superiority of the electrical process is most conspicuous. Messrs. Lloyd and Lloyd are to be congratulated on their persistent efforts to bring the Benardos system to such a degree of success.

The Crystal Palace Exhibition.

THE 9th of this month has been fixed for the opening day of the Electrical Exhibition, and we trust that exhibitors will do the utmost to have their exhibits in readiness, for nothing is more depressing to visitors than to find empty or half completed stands, although this is the rule rather than the exception. However, the Crystal Palace is so easily reached, and goods, once inside, so readily handled, that possibly our fears that everything will be in a more or less chaotic state, are groundless.

THE WIRING OF HOUSES FOR THE ELECTRIC LIGHT.

BY ED. C. DE SEGUNDO, A.M.I.C.E.

THE author feels that some few words of preface are necessary for this paper, as from the title, a more comprehensive treatment of the subject might be expected than is contained in the following lines. Consulting electrical engineers will probably find no new matter in this paper, but the author submits that his remarks are not intended for those who have already a complete knowledge of the subject, but for those who are occupied in branches of engineering remote from electricity, and who have no opportunity or time for enquiry into this question, to whom, further, an explanation of the methods of wiring a building for the electric light might be of some assistance in forming an opinion as to whether the numerous accidents laid at the door of electricity are in reality the outcome of unavoidable risks inherent in electricity, or whether these cannot be not only minimised, but actually entirely obviated, by introducing proper precautions when laying down the wires and other apparatus in the first instance.

That the horrible tales of the doings of that demon electricity which have come to us, notably from the States, should have inspired the uninitiated with a wholesome dread of any electrical enterprise under any conditions whatsoever, is perhaps to be understood, but that England—and, above all, this City of London—the centre of the commercial and scientific world which otherwise has ever held its place in the van of the march of civilisation, should have remained so long unmindful of the advantages of the use of electrical energy for the production of light is certainly not quite so easily understood.

That the electric current in a building is *per se* a source of danger the author is prepared to deny; that it may become such through the carelessness of those using it, it would be folly to deny, but that the use of the electric light in a building is, in the ordinary course, as fraught with risk as the use of gas, can again be emphatically denied.

The author feels all the more confident of the reasonableness of this view when he considers the number of electric light installations—his own amongst others—which have given every satisfaction for years in return for a little—very little, comparatively speaking—care and supervision.

There is no mystery about electric lighting. It is a perfectly straightforward process, and most, if not all, the serious mishaps are attributable to the fact that those in authority have been wanting in engineering training, that they have been more electricians than engineers; and as long as large and important electrical plant are left in the charge of so-called electrical engineers whose sole qualification consists in having wasted a year at one of those wonderful institutions which claim to turn out electrical engineers in one or two years, so long will a recurrence of deplorable accidents take place, such as have already injured to so great an extent the industry of electric lighting.

There can certainly be no doubt of the great advantage of the electric light in rooms where ventilation is poor, as the incandescent lamp gives very little heat, and does not consume any oxygen. It has been urged by those interested in gas that a large public hall lighted by gas is better ventilated than if electrically lighted. This may be true in cases where sunlights are fixed at the base of a ventilating shaft, and where the number of burners bears a small ratio to the number of people present. It does not obtain, however, in offices or dwelling houses, or in any buildings where no ventilation exists, and where the ratio of gas burners in the room to people inhabiting the room approaches unity.

The author proposes to examine this subject from the consumer's point of view, and will divide the following remarks under two main heads by considering to what extent the interests of the consumer of electrical energy are protected in the matter of the internal installation of his house by the requirements of the electric supply company and of the insurance company and of the Board of Trade, and by looking briefly, and as simply as possible, at the technical side of the matter.

First, then, as to the protection afforded by the supply company.

A supply company is established as a commercial concern. Its object is to make money. The efforts of the directors must therefore be aimed at supplying as many consumers as possible. They must therefore not be too particular as to the quality of the work done in the consumer's house, and thus run the risk of frightening away intending clients by the expense. Further, for obvious reasons, no supply company of importance—to the knowledge of the author—contracts for wiring houses. This is another reason why the company's standard has to be as low as possible.

The supply company certainly do their best by prescribing certain tests which the wiring of any building must successfully endure before the supply of current to the building will be sanctioned. But this is not sufficient. The test consists in measuring how many units of resistance are offered by the insulation of the wires as a whole to the passage of the current from the conductor to earth, the test being now usually made at the working electromotive force. The method of wiring is also subjected to an inspection as far as this is possible. But the company cannot superintend the process of wiring a building, and consequently the test which is made by the inspector proves only quantity of insulation and not quality, and tells nothing of the amount of copper in the mains, nor can it reveal other deficiencies which may exist, and which are of importance to the consumer.

The supply company protects itself sufficiently when doing that part of the work over which it very rightly reserves to itself full control—namely, the connection of the secondary mains of the house to the supply mains. If anything goes wrong with the consumer's wiring—such as a wire or lamp terminal coming in contact with a gas or water main, or such as a short circuit when two wires of opposite polarity become connected through a small resistance (which would occur when, for instance, a pair of mains were divided simultaneously by an axe), certain automatic apparatus fixed by the supply company would come into operation and effectively cut off the installation from the main supply before any great damage could be done at the central station, and the company's machinery would be safe. But the sparking which would have been occasioned in the consumer's premises by the arc which would have been set up, however the short circuit was effected, would have been sufficient to set inflammable material in the immediate neighbourhood of the accident on fire.

A condition which has been introduced into the wiring rules of the Metropolitan Electric Supply Company is of great value, as tending to render the installation a satisfactory one as well as a safe one. They stipulate that the wiring should be carried out in such a way that the drop in pressure at the terminals of the furthest lamp at full load shall not exceed two per cent. of the pressure at which the current enters the building.

As the insurance company's interests are included in those of the consumer, the latter obtains a little more protection by insisting that the contractor should carry out the installation in conformity with the requirements of the insurance office's specification, but here again the insurance company are only careful as to the safety of the building insured, and the same remarks apply to them that were made in regard to the supply company, as to the *quality* of the work—namely, they cannot undertake to superintend the execution of the work, and what might be a perfectly *safe* installation, might be a very unsatisfactory one for the client, as will be evident from what follows later on.

Then in regard to the Board of Trade, the regulations issued by the board are not intended to apply to private consumers, and, in fact, they do not apply. Up to the present the Board of Trade have only issued regulations controlling the action of public supply companies.

In doing this, of course, the Board of Trade have had at heart the welfare and safety of the public at large, and the measures adopted by the Board of Trade have been such as at times to overlap the domain of the welfare and safety of the individual consumer.

It must not be inferred from the foregoing that efforts have not been made to frame a code of laws for the proper installation of wires in a building. The Institution of Electrical Engineers, and nearly all the insurance offices, have drawn up rules which they recommend for the guidance of wiring contractors.

It is unlikely that the Board of Trade will ever be able to

legislate in the direction of controlling the manner in which electric light wires should be run in a private house. It is argued that a man has a perfect right to do what he likes with his own, and may run any personal risk he pleases. This is certainly true; and any legislation controlling a man's action in these directions would constitute an interference with the liberty of the subject. But it may be respectfully submitted to the Board of Trade that when rows of houses are built contiguously the above conditions no longer obtain, and fire risks in one house constitute a source of danger to the next. Further, in the case of a theatre or other public building, any risk or danger existing in that building certainly becomes a risk or danger to the public. But, without a special Act, the Board of Trade cannot interfere with or control the manner in which the theatre or public building is supplied with electricity. Every clause of the Electric Lighting Act shows that any responsibility in regard to private buildings has been most carefully avoided. Of course, the interference of a public body in private matters is not always an unmixed blessing; but, as the way in which a house is built is controlled by the Building Act, for the reason that a man may not endanger his neighbour's house by reckless building, so it seems not unreasonable that the way in which it is fitted up should also be under responsible and competent control, in so far as the interests of others are or may be affected.

But recommendations in themselves are valueless unless they are enforced where necessary, and the reason why any set of rules cannot be enforced as a whole, is, because it is simply impossible to draw up a model set of rules to which each and every electric light installation shall conform. The proper drawing up of the specification for the wiring of a building and for the design of the necessary plant, demands an intimate knowledge of all the circumstances of the case.

To draw an analogy from steam engineering, it is manifestly absurd to recommend $\frac{3}{4}$ plate for a small boiler if the safety valves are to be loaded to 30 lbs. per square inch, and it is equally absurd to include a condenser, feed-water heater and water softener in the specification for a half horse-donkey pump and boiler; and yet equivalent absurdities are sometimes insisted on by the inspectors of the fire insurance offices, while more important matters are not entered into, and grave defects overlooked.

But one of the crowning triumphs of inconsistency in electrical practice is the electrical analogue of testing a boiler which is to work at a 100 lbs. per square inch by water pressure at 6 lbs. per square inch, namely, testing an installation which is to transmit current at 100 units of pressure by means of a few primary cells giving about 6 units. This is by no means an antiquated method, but it is, however, fair to say that it is fast becoming obsolete, and improved methods of testing the system of wires are coming more generally into use. The most complete set of rules as yet drawn up, and one based on long practical experience, is that compiled by Mr. Musgrave Heaphy, the engineer to the Phœnix Fire Office. Yet the very completeness is in itself perhaps a drawback, tending as it would, in the hands of less experienced men, to the commission of numberless and ridiculous inconsistencies. The author was recently interviewed by the acting electrical inspector of a well-known fire insurance office in London, on the question of the safety of a few 8 candle-power lamps which were to be supplied from an accumulator charged by a primary battery at a pressure of 20 volts. The inspector admitted he knew nothing about the subject, but produced a book of rules, and said that as long as the conductor could safely carry double the working current, and if there was a main switch and a fuse somewhere, he would be satisfied. Now, clearly the inspection of such an officer is no guarantee whatever of the quality of the work done.

At this point it will be, perhaps, necessary, as the author is not addressing himself exclusively to electrical engineers, to consider what are the essential qualities in a system of electric conductors for a building which shall combine efficiency with safety and economy; and here, perhaps, will be the best place to make a slight digression for the purpose of putting into ordinary technical language the necessary electrical quantities with which the author will unavoidably have to deal.

As to electrical quantities, only three may be considered: The electromotive force, the resistance, and the numeric of their ratio called the current intensity. That a volt is the practical unit of electrical resistance is probably known to everyone. It is also to be presumed that everyone has heard of "Ohm's law," which states that the intensity of current is proportional to the quotient of the numeric of the electromotive force existing at any two points in the circuit by the numeric of the resistance between those two points. But what is not generally recognised is that Ohm's discovery did not take this shape. He found that for a given conductor the ratio of electromotive force to current passing was a constant quantity, or $R = \frac{E}{C}$ within certain limits when a steady current is flowing. Thus it is seen that the resistance is the only fixed quantity, and that the current cannot be spoken of as having as independent an existence as the resistance. A current of electricity cannot be said to exist any more than a current of water. The word "current" is used to denote a state, and in electricity that state is conditioned by the ratio of the potential difference at two points joined by a conductor to the resistance of the conductor. Hence it is possible to produce the same intensity of current at any pressure, high or low, by suitably varying the resistance through which the difference of pressure is allowed to equalise itself; and as it is the current intensity which governs the degree to which a conductor transmitting it will be heated, it is at once evident that the electromotive force and the resistance of a circuit must both be known when designing a circuit. It also follows from this that dangerous currents do not necessarily imply dangerously high electromotive force, but could also be occasioned by a too low value of the proportion the resistance bears to the electromotive force; from this, it follows, the higher the difference of potential between two points the larger will the current be if the resistance between those points remains the same.

Ohm, of course, did not have an opportunity of practically testing the applicability of his law to alternate currents. As a matter of fact, his law does not apply with absolute accuracy to either alternate or continuous currents; indeed, it is somewhat difficult to determine practically the resistance of circuits carrying alternate currents as compared with the circuits carrying continuous currents. Accurate instruments for this purpose have not yet come into general use. It is probable that some form of instrument based on Sir W. Thomson's "electrostatic" principle will shortly be in the market for practical work. However, for the purpose of house-wiring, it may be taken that the resistance of a wire to the passage of a continuous current is practically the same as that offered to the alternate current, certainly within the limits of pressure at which current is supplied to houses.

The purpose of the writer is not to draw up a set of rules. Rules unmixed with brains frequently do more harm than good. The author proposes in the following lines to draw attention to the important features in the installation of a building, with the necessary wires and other apparatus for conveying electrical energy to lamps.

The chief considerations are (1) the amount of insulation the wires should bear, (2) the intensity of current that should be allowed to pass through them, (3) the manner in which the wires are erected, (4) the type of safety precautions, and (5) the insulation resistance of the installation considered as a whole.

(1) In regard to insulation, quantity is often thought to be synonymous with quality. This is misleading, and the fallacy of this view may be illustrated by citing an extreme case. Insulate a bare wire by running it through a small glass tube. Its insulation resistance per mile in water (water being excluded from the inside of the tube) would be many thousand million ohms, but bend the wire, and in so doing, crack the glass, the insulation resistance immediately sinks to nil. Here the quantity was large, but the quality undesirable. Thus it is not sufficient to specify what the insulation resistance of a wire should be, but the manner of insulation should be specified, to suit any special conditions under which the wire may have to be used.

The amount of insulation on the wire should bear will depend upon the uses to which it is to be put. For aerial work the same amount is not necessary as for underground work, especially if the underground wires are exposed to damp.

But whatever the number of units of resistance may be

thought necessary for any wire, there can be no doubt that the best known quality of insulation should be insisted on.

As to the necessary quantity of resistance :—

It should be borne in mind that the insulation resistance of an installation is not lowered merely by the length of cable used, but chiefly by the interruptions in the continuity of the run of casing and of wires. The extent to which the insulation resistance is diminished at joints, lamp terminals, switches, &c., is very great.

To take an example from practice, wire of class K, Silvertown manufacture, offers a resistance of 600 million ohms per statute mile to the passage of the current from the copper conductor to the water in a bath at 60° Fahr. It may further be taken that the resistance of half a mile would be twice as great, and so on inversely as the length. Say now a quarter of a mile of this wire is used in wiring a house for 40 8-C.P. lamp, arranged in four circuits of 10 lamps, with a main switch, four cut-outs on each pole, and 40 switches ; the resistance of this length of wire, which would be 2,400 million ohms in the bath at the manufacturers, will be found to have sunk when tested in the house to about two million ohms, if the work has been very carefully done, and if the house is dry and the weather fine. Should the house be newly built, the resistance will sink to about 100,000 ohms on a wet day. Of course, even the lowest limit does not of necessity bring any disastrous consequences about, for the leakage is only $\frac{1}{100}$th of an ampère, if the pressure of supply is 100 volts. The chief disadvantage in this case would be that the amount of electricity leaking would pass through the meter, and consequently have to be paid for.

It should also be remembered that an electrical leak to earth is independent of the quantity carried, and is determined only by the electromotive force. In regard to this question of earth leakage, it would be well to point out that a single weak place in the insulation would not cause an earth leak. There must be at least two weak places whose resistance to earth is small before anything but a static charge of electricity could thereby be lost. This may be illustrated by the following analogy :—

Consider a tank filled with some liquid, the bottom of which communicates with another tank, which may be empty or may contain water up to some lower level than that of the liquid in the first tank.

If communication be opened the liquid will flow until the same level is reached in each vessel. But consider the electrical analogy, take a source of electrical pressure, say, a primary battery, connect either the positive or negative wire singly, and one at a time, through a detector to earth. If there is no other connection to earth the result will be absolutely nil ; that is, no current will pass. Electricity requires a closed cycle before it will pass from the potential to the kinetic state. Thus, if one could be sure that no leak to earth existed on any part of a circuit carrying a potential of 10,000 or 10,000,000 volts, absolutely no effect would be produced by grasping the bare conductor at any point as far as the passage of a current is concerned. It must not, however, be concluded from this that bare conductors may always be handled with impunity, for a serious shock due to a discharge of static electricity may be sustained if the conductor in question forms part of a large switchboard containing much insulated metal. In as much as ideal conditions are never realised in practice, it is not only advisable, but really essential, that all metal carrying a current at other than harmless pressures should be covered with insulating material, or in some way protected, so that it is impossible, under ordinary conditions, for persons to touch it.

Further it should be borne in mind that the longer the cable or wire the less does the insulation resistance become. The term insulation resistance per mile does not mean that every mile of cable is guaranteed a certain insulation resistance, and that therefore 10 miles of cable would have ten times the insulation resistance that one mile has. Quite the contrary, it would only have $\frac{1}{10}$th (roughly speaking) of that of one mile.

Engineers are told to think of resistance to the passage of an electric current as analogous to the friction in a pipe. This is quite true, as far as applies to the conductor itself; still the analogy, though somewhat strained, may be considered to apply to the case of resistance to the passage of the current from the conductor to earth, for there is no such thing as a perfect insulator, therefore the insulation round a wire may be considered as the equivalent of a spongy cast iron pipe through which water is led at various pressures.

Evidently the higher the pressure the more water will pass through the thickness of the pipe, and evidently, also, the total loss from this cause will vary directly as the length.

(To be continued.)

POLYPHASED ALTERNATE CURRENTS.

By RANKIN KENNEDY.

UNDER this title a series of very instructive articles has just been concluded in your pages. Although the appliances and methods just at present used in the utilisation of polyphased alternate currents do not seem to be altogether perfect, and even although accurate figures regarding the performance of polyphased generators, motors, transformers, and other appliances cannot at present be obtained, yet there seems to be possibilities in a system employing polyphased currents which do not exist in a simple alternating current system, and which do not exist in continuous current systems.

The simple alternate current systems have not been able to offer a solution of problems, as to the supply of motive power, nor as to charging storage batteries, nor as to converting the alternate into a continuous current.

The continuous current systems present difficulties in the way of high pressure distribution and in transforming from one pressure to another. High pressure continuous current generators have not been hitherto regarded as successful, and present great difficulties both in their construction and in the collection of their currents. Continuous current transformers are neither more nor less than two dynamo electric machines combined into one machine ; they are somewhat delicate, and require constant skilled attendance. With the continuous current system we can supply motive power. electric lights, storage batteries, and all other customers, but it is limited practically to low pressure, about 220 volts, and is very difficult and expensive to transform into high pressure and down to low pressure again.

With simple alternate currents we can work at any pressure, and transform up or down with the greatest of ease and with comparatively little loss, but they are available only for lighting purposes.

The object of the various polyphased systems now being put forward is to combine the advantages of both the simple alternate current system and the continuous current system in one complete system.

There seems to be no reason why this object cannot be attained, as with various combinations of two or three currents alternating in different phases, a supply of electrical energy is rendered available for any purpose to which continuous currents are applied, while all the advantages of the easy transformation of the alternating current is retained ; and there are no difficulties with high pressure alternators, up to two or three thousand volts at least, and polyphased motors require no commutators nor brushes, and that alone is a considerable advantage. Of course, there is much to improve and develop before these recent generators and motors connected with polyphased alternate currents can be realised as commercial appliances, but nevertheless they must be considered as rivals to the existing appliances.

Considering the shortcoming of the two systems now in use, it is not surprising that endeavours are constantly being made to devise a system to meet the requirements in electrical distribution of energy applicable to all purposes to which electrical energy may be applied and easy of transformation to any pressures.

The systems proposed employing polyphased alternate currents are the Schuckert, a two phase quadrature alternate current system ; Rankin Kennedy's duplex quadrature alternate current system ; Dolivo-Dobrowolski, Haselwander and Brown's three-phase systems. All of them use at least three wires or four wires in their distributing mains ; but that is a matter of no consequence whatever and is not peculiar to these systems. Most of the continuous current systems in use are on three wire systems of mains, and some on five wires.

The development of polyphased alternate currents has been the feature of the electrical progress of 1891, and, no doubt, they will attract a considerable amount of attention during 1892.

THE WESTON DIRECT READING ALTERNATING AND CONTINUOUS CURRENT VOLTMETER.*

THE modern applications of electricity have called for the invention and perfection of many auxiliary devices as safeguards to the circuits carrying the current and also of apparatus for ascertaining the condition of the circuit at all times. Among the latter, the various types of measuring instruments, such as ammeters and voltmeters, have deservedly been the object of much study by many eminent electricians, with the result that the forms which have been devised are only limited by the number of phenomena which may be employed to indicate the presence of an electric current. But apparatus intended for the purpose of affording indications of the condition of electrical circuits, in order to possess value, must be so designed and constructed and embody such principles of action as will permit its indications to be practically constant under all conditions of fair use, and continue so for an indefinite period.

Realising these important factors, Mr. Edward Weston several years ago, invented a type of measuring instrument which embodied in its construction a permanent magnet and a movable coil, which moved in the gap included between the poles of the field magnet and a soft iron core. This combination formed practically a closed magnetic circuit, which experience has proven to be practically absolutely permanent in its nature. In proof of this we need only cite an experiment which we saw performed and which was as follows: A continuous current voltmeter of the Weston type was attached to a circuit reading 100 volts and by bringing a magnet in contact with the poles of the magnet of the instrument itself, so that the N and S poles respectively came in contact, the reading of the instrument was changed from 100 to 22. The magnets were then struck repeated blows with a hammer in order to facilitate any change which might take place in the condition of the magnet of the instrument. The auxiliary magnet was then withdrawn, whereupon the needle resumed its original indication of 100 volts within one-tenth of a division, proving practically that no sensible change had taken place in the condition of the magnet.

The experiment was then tried of increasing the strength of the instrument magnet by placing the N pole of the auxiliary magnet in contact with the N pole of the instrument magnet, both S poles also being in contact. The increase in the field thus brought about served to throw the index off the scale. The shocking of the magnets was then repeated, but, upon withdrawal of the disturbing magnet, the index resumed its first position within less than one-tenth of a division. A more crucial test could not be devised so show the permancy of the magnets employed by Mr. Weston in his well known type of instrument. Indeed, Mr. Weston goes even so far as to place greater reliance in his instruments than in the tangent galvanometer, owing to the fact that the latter changes its indications with every change in the intensity of the earth's magnetism; whereas his instruments, when standardised, have proved their stability, entirely independent, of course, of all except the most powerful external magnetic influences.

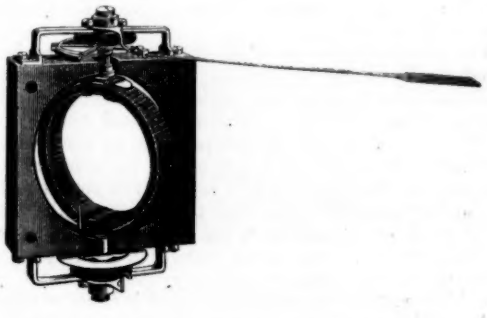
With this success gained in the field of continuous current instruments, Mr. Weston proposed to himself the problem of constructing an instrument of like accuracy and permanency which could be used equally well on circuits carrying either alternating or continuous currents. Those who have had experience in the measurement of alternating currents, will readily concede that the task undertaken by Mr. Weston was one of no mean proportions, but that, on the contrary, its successful solution might well demand the highest ingenuity, not only in the application of electrical principles, but also in the exercise of mechanical skill, in order to make such an instrument an everyday working tool for electricians.

* *Electrical Engineer*, New York.

In casting about for the best principle upon which to construct such an instrument, Mr. Weston, after much thought, turned to the application of the principle embodied in the electro-dynamometer, that is, a fixed coil acting on a movable coil; but the mere selection of this principle by no means gave the solution of the problem. It must be evident that in order to be equally applicable to both continuous and alternating currents, the instrument must have practically no self-induction. How to obtain this condition with coils carrying alternating currents may be said to have been the problem solved by Mr. Weston. Starting with the fact that the self-induction of such a system depends primarily upon the strength of the current and the number of turns in the coils, Mr. Weston at once set himself the task of reducing the current required to operate the instrument to the smallest possible amount. The corollary to this was, to construct the instrument so that its moving parts should have the least possible weight, and that the friction should be reduced so as to make the instrument as sensitive as possible. To what degree Mr. Weston has succeeded in fulfilling these conditions will be apparent when we state that the moving coil, pointer, springs and pivots of the new instrument weigh together only 31 grains, that is, less than one-fourteenth of an ounce.

The most essential part of the instrument, of course, is the system of fixed and movable coils, the latter being shown in the figure. The movable coil consists of copper wire ·002 inch in diameter, the fineness of which can be judged from the fact that the average human hair is ·00225 inch. The diameter of the coil is 1¼ inch, and it is wound so that it presents a ⅛ inch square section, consisting of 525 turns. As the proximity of any considerale quantity of metal near the coils would introduce disturbing factors, it became necessary to avoid the use of a supporting spool for the wire of the movable coil, which upon trial, was found to be quite stiff enough without a spool. The pivots upon which the coil turns are attached to it by means of small aluminium plates, which are first cemented to the coil and then wound with silk thread. The pivots consist of hardened steel, which are ground to gauge and polished. The entire movable system, as stated above, does not exceed 31 grains in weight.

It might be urged that the weight of the coil could have been still further reduced by the employment of aluminium wire, and this, as a matter of course, also suggested itself to Mr. Weston. Indeed his first instruments actually embodied aluminium wire coils, but it was found that aluminium could not be drawn practically below ·005 or ·006 of an inch, although Mr. Weston himself has, with great care, succeeded in drawing it down to ·00325; but as a still finer wire was needed in order to meet the requirements of the case, Mr. Weston was obliged to fall back upon copper, aluminium being employed wherever possible in the other parts of the movable system. It will be noted that the coil is balanced practically for all positions, in the same manner as a watch balance, and, as in the magnet type of Mr. Weston's instruments, acts against the force of very delicate springs which also serve to carry the current to and from the coil.



It will also be noticed that the coil is provided at its lower end with a disc which constitutes part of the friction device provided for the purpose of damping the instrument. It will be evident that, as above stated, the placing of any metal near the coils to effect damping would cause injurious reactions. In the same manner magnetic damping was not

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permissible as it would cause the indications to differ with the rate of frequency of the alternating current; hence it became necessary to control the instrument by mechanical means in order to bring the parts quickly to rest. The brake in the instrument is combined with the contact key. The brake normally presses against the disc and holds the moving parts rigid. When the key is depressed the current is first turned on and then the friction is gradually reduced just sufficiently to allow the coil to gradually move along until, by the time the key is fully depressed, it has reached the position due to the action of the current and indicates the proper reading on the scale. Thus while the instrument in itself is not dead-beat, the means provided by the brake allow readings to be taken nearly as quickly as with a dead-beat instrument.

The stationary coil which surrounds the movable one just described, consists of wire ·003 inch in diameter, the number of turns of which is as small as possible compatible with securing the necessary field of force, the coil being wound on a very thin, hard rubber shell. The amount of current needed to move the index across the entire scale differs somewhat in the various ranges made, varying from ·02 to ·056 of an ampère in the two scale instrument, with the lower scale reading to 60 volts and the upper to 120. The resistance of the instruments averages for 60 volts about 1,100 ohms, and for 120 volts about 2,200 ohms. In single scale instruments the resistance is generally much higher and the current lower. The principal resistance is in the form of a non-inductive resistance coil outside of the operative system, which is placed in series with the latter, the movable and fixed coils also being in series.

Not the least important part of the instrument is the means afforded by it, of obtaining correct readings at all ranges of working temperature. It is a common practice of instrument makers to attach to their instruments a table, giving the temperature corrections, based merely on the changes in the resistance of the copper coils in the instruments; but it by no means follows, as will be presently shown, that such corrections will give accurate results, and, that, indeed, the indications may vary very largely from the truth when so corrected. While it is true that an increase in temperature of 5° F., for instance, increases the resistance of copper by about 1 per cent., a like change of temperature in the magnetic system of an instrument, may cause changes which may be either positive or negative in their nature, according to the type of instrument. In Mr. Weston's magnetic voltmeters the relationship is such that the increased resistance due to increased temperature in the wire, is almost exactly counter-balanced by an increase in the magnetic system, due to elevation of temperature. Consequently the instrument itself compensates almost perfectly for the change in resistance of its coil, due to changes in temperature. The new alternating current instrument has decided the fact that it was impracticable to compensate directly for both of these sources of error; but there is added a thermometer, the bulb of which extends over and comes in contact with the coils and is so flattened and contains such a small amount of mercury so as to give quick response to the slight changes in temperature of the coil. The stem of the thermometer is placed below the glass cover and can be easily read.

The compensation for changes in temperature is provided for by means of a minute rheostat which has a dail graduated into 20 parts, each indicating a change of 2½° F., and the whole extending between 60° and 100° F. This provides for a change in temperature of 50°, which is sufficient for all practical purposes. To compensate for temperature, therefore, it is only necessary to note the reading on the thermometer and to turn the pointer of the rheostat to the mark corresponding to the temperature indicated by the thermometer. The actual changes in the resistance due to temperature are small, as a large proportion of the resistance is German silver, less than $\frac{1}{10}$th of it being of copper.

A question which many will ask regarding the instrument is: Will the indications vary with currents of different number of alternations? The practical elimination of the effects of self-induction, as described above, is the best answer to this question. Experiment has shown that no difference can be detected in the readings of this instrument between a perfectly continuous current and one varying from that up to 300 alternations per second, a range covering all practical systems of electrical distribution in use at the present time, and proving the instrument to be practically without self-induction.

It is interesting, as showing the marvellous delicacy and accuracy of the instrument, to note that a weight of ·4 of a gram, about six grains, acting on the movable system at a radius of half an inch, will cause the index to move entirely across the scale, and, as the instrument is sufficiently sensitive to indicate $\frac{1}{1000}$th of the whole scale, it will indicate to the $\frac{1}{1000}$th part of ·4 gramme, that is, ·4 of a milligramme, or about $\frac{6}{1000}$th of a grain. Indeed it has been suggested that the instrument might be used as a delicate balance. Of course such a result can only be obtained by the reduction of all the moving parts to the smallest possible mass and by very excellent workmanship. As Mr. Weston correctly argues, lightness is necessary not only for accuracy in an instrument, but its very life is dependent on it, as lightness means reduced friction and wear on the pivots under ordinary use as well as that from shocks to which portable instruments are inevitably subjected. In one type of instrument two scales are provided, the upper reading up to 120 volts, and the lower to 60. In this way accurate readings can be obtained over both ranges. Instruments are now made which have a range as low as 20 volts with full-scale deflection, and others requiring 5,000 volts for the full-scale deflection. A large variety of intermediate ranges are also made.

It is almost needless to remark that the instrument is characterised by that beauty of design and fineness of work common to all Mr. Weston's work. No detail seems to have escaped his attention and the whole instrument evidently has had every care and attention given to it, to make it eminently suited for the work to be done. The instrument has been under close examination and test for several years, and as now constructed may be considered standard in type and free from all elements tending to introduce error.

THE GÜLCHER THERMOPILE.

WRITING some time ago on the Gülcher thermopile, we admitted that the consumption of gas by this generator amounted to 20 cubic metres per kilowatt-hour. In the last number of *Electricity*, we find an article written by Dr. Julius Maier, which somewhat alters our relatively favourable opinion expressed at the time, and throws some doubt on the truth of the information received concerning this too much praised thermo-electric generator. The experiments alluded to by our contemporary were made by the maker, Dr. Julius Pintsch, of Berlin, and occupied more than one month. We give here the principal results obtained and mentioned by Dr. Julius Maier.

It was found that, working with the maximum current, the elements must not be heated so much as to produce in open circuit an E.M.F. of 4 volts (·08 volt per element in a pile of 50 elements). At that respective temperature the alloy of the elements is caused to be partly decomposed by the current, and the internal resistance of the pile increased accordingly.

The highest point to which the elements can be heated without fear of destruction was ascertained by careful experiments, and this was found to be equal to an E.M.F. of ·07 volts per element. To be on the safe side, however, the nose-pipe of the apparatus is now only made wide enough to allow the quantity of gas necessary to produce the mentioned E.M.F. of ·07 volts, to pass through at the maximum gas pressure to be found in practice—*i.e.*, that equal to a column of water of 50 millimetres.

With this precaution the elements produce, at the ordinary medium gas pressure (equal to a column of water of 30 millimetres), an E.M.F. of only ·06 volts each, and consequently there is now no danger as regards destruction either by the current or overheating. In spite of the smaller E.M.F. per element, the useful effect of the pile has remained nearly the same; for, to produce an E.M.F. of 3·5 volts, formerly from 200 to 230 litres of gas per hour were required, whereas now only about 130 litres of gas per hour suffice to generate an E.M.F. of 3·0 volts.

According to the various purposes for which the piles may be used, and to which reference will be made later on, three different types are now manufactured by the makers:

Type No. 1, consisting of 26 elements, producing an E.M.F. of 1·5 volts, consuming about 70 litres of gas per hour; internal resistance about ·35 ohm.

Type No. 2, consisting of 50 elements, with an E.M.F. of 3·0 volts; about 130 litres of gas per hour, and an internal resistance of about ·50 ohm.

Type No. 3, consisting of 66 elements, with an E.M.F. of 4·0 volts; about 170 litres of gas per hour, and an internal resistance of about ·65 ohm.

From these facts we can easily form a table showing the various conditions of working of each type, and so facilitate their comparison. We reproduce here this table, calculating the maximum available power by the well-known formula:

$$P = \frac{E^2}{4r}$$

E being the electromotive force of the thermopile, r its internal resistance, and P the available maximum power.

	Type 1.	Type 2.	Type 3.
Number of elements ...	26	50	66
Consumption of gas in litres per hour	70	130	170
Electromotive force, E (volts)	1·5	3	4
Internal resistance, r, (ohms)	·25	·5	·65
Maximum power available, P (watts)	2·25	4·5	6·1
Consumption of gas in m^3 per kilowatt-hour ...	31	28·9	27·8
Energy available produced daily (24 hours) by continuous work (watt-hours	54	108	146·4

Dr. Julius Maier, then proceeds to describe the various uses to which the thermopile can be put for chemical and physical laboratories, medical purposes, dental operations, telegraphy, galvanoplastie, schools, demonstration, and, lastly, for the short and temporary lighting of glow lamps in small installations.

We have grave doubts as to the possibility of this last application, but we reproduce here the writer's statements:—

In connection with a special *automatic switch* and 8 accumulators of 30 ampère-hours capacity each, *one* large thermopile suffices for burning daily:—

One	6-candle	lamp	for 12	hours.
Two	„	lamps	„ 6	„
Three	„	„	„ 4	„
Four	„	„	„ 3	„
Five	„	„	„ 2·4	„
Six	„	„	„ 2	„
Twelve	„	„	„ 1	„ &c., &c.

It must be mentioned that, for the applications mentioned under Nos. 4—7, the thermopiles must remain in *uninterrupted operation*. There is no objection to such continuous working; on the contrary, it recommends itself, both from the point of view of economy and durability of the elements.

This is absolutely impossible, because a lamp of six candles takes no less than 20 watts. If the lamp must burn 12 hours daily it will consume 240 watt-hours, and the most powerful Gülcher thermopile can only produce 146, or, say, 150. But the accumulators will deliver no more than 120; that is exactly *half* of the requirement of the 6-candle lamp burning 12 hours daily.

When will the time come in which calculations made will be, we will not say not correct, but consistent and coherent? The only explanation we can suggest of this curious statement is, that Dr. Julius Maier knows nothing about the formula giving the *true* available maximum power of a thermopile? Is this the case? We anxiously await an answer.

With regard to the cost of electrical energy produced, we can see by the figures that the consumption of gas is nearly a thousand cubic feet per kilowatt-hour or Board of Trade unit.

CRYSTAL PALACE ELECTRICAL EXHIBITION.

WE supplement our last week's list with the following names of exhibitors and exhibits:—

Allsop, F. C., and Company: Telephones and all accessary apparatus.

Anderson, R., and Company.

Andrews, J. D. and F.: A complete system of concentric wiring embodying street mains with transformer for high pressure system; street mains for low pressure 3 wire system; concentric wiring and fittings for house and ship lighting, &c.; switches and fuses, and other appurtenances, details of joints, and tools for same.

Archer Pipe Company.

Bishop, W. J.; Botting, J., and Company; Bristol, L.

Central Electrical Company, Limited, will show portable batteries, meters, motors, carriage lamp and tricycle, magic lantern and other batteries.

Cutling Douglas, R. C., and Company.

Dan Rylands, Limited: Patent glass-lined tubing for electric wires and cables; patent Leclanché jars with bottom for holding the porous pot perpendicular; glass battery bases; glass insulators, dishes, jockeys, and other electrical glassware.

Dent and Company.

Easton and Anderson, Limited, will show one of Stoker's patent high speed engines running at 500 revolutions and driving a 600 light dynamo; a Bunstead and Chandler's engine driving a 300 light dynamo at 380 revolutions; a Robey high-speed engine driving a 3LL light dynamo. The current is supplied to various parts of the Palace driving motors and lighting stands; all dynamos and motors constructed in accordance with Prentice's patents and designs, whose business was absorbed by Messrs. Easton and Anderson, Limited, last spring.

Electric Construction Corporation, Limited: Elwell-Parker continuous current transformer, 40 kilowatts, 1,000 volts to 110 volts; Elwell-Parker alternating current dynamo, 30 kilowatts; Elwell-Parker continuous current dynamos and motors; Elwell-Parker alternating current transformers; instruments, switches, magnetic cut-outs, &c.

Electric Stores, Limited, will show, E.S. dry battery; E.S. dry battery plating set; "Compact" dry battery cell; patent portable electric combination bell; patent double contact press; E.S. portable lighting set.

Exchange Telegraph Company, Limited.

Fowler, Lancaster and Company, Limited: Main switch-boards, switches, cut-outs, wall plugs, ceiling roses, lamp caps, lamp-holders, cord ornaments, balance weights, removable bar cut-outs, lever switch cut-outs, our patent ceiling roses, branch switches, and other sundries in the chinaware line. Specimens of wood work, electroliers, brackets, standards, pendants, and other ornamental fittings.

Fox, E.; Freeman, W. S.

Harris, J., will show "Harris's" amalgamating machine for the economical extraction of gold and silver from crushed ores.

Hookham, Messrs., will exhibit patent automatic make and break circuit electric bells, long contact bells, duplex electric alarm clocks, electric clocks, bells, batteries, indicators, telephones, &c.

Jennings, George: Jennings and Brewer's patent electro-mechanical apparatus for indicating and registering varying levels of liquids at any distance from the point of observation, as, for instance, outlying reservoirs, sewage tanks, outfall sewers, rivers, &c. Improved telephonic system affording complete interchangeable communication between all points. Improved forms of electric bells, pushes, signals, &c.

Joslin, P.

London, Brighton and South Coast Railway: Exhibit of the Locomotive and Carriage Department: Model of the ss.'s *Rouen* and *Paris*; model of electrical communication between passengers, guards and drivers; 10 photographs as under, engine "Edward Blount," boiler, cylinders and gradient, working drawing "A" class engine, "Minories"; "C" class engine; "D" class engine, "Mayfield"; "E" class engine; "G" class engine, "Imberhorne"; Pullman car, interior and exterior; royal train. Exhibit of the Telegraph Department: Block signalling and speaking telegraph instrument as in use nearly half a century ago, and others with the various improvements up to date, including train describers, and Perry and Houghton's tunnel alarms which automatically warn workmen of the approaching trains.

L. & N. W. Railway.

London, Chatham and Dover Railway: "Sykes's combined lock and block system of railway signalling," as used on the Chatham and Dover and many other railways in the United Kingdom, on the Continent, and in the U.S. of America.

Moore, B. F.

Mosses and Mitchell will exhibit their vulcanised fibre in various forms for insulation; also Moore's patent desk clamp.

Moser, F.: Chandeliers, candelabras, and the finest decorated Bohemian glass which shows the brilliancy of colours when lighted up; also shades, fittings, &c.; also electro-plated and fine artistically cast iron tables, &c.

Napier, D., and Son: Speed indicators, electrical coin weighing machine, drilling and tapping machine.

Post Office, H.M.

Richards and Ward, Limited: Electrical writing telegraph.

Richards, J. M.; Riedel, Herr.

Ropers's Electrical Engineering Company, Limited: One 65 volt, 185 ampère, drum armature dynamo; one 110 volt, 32 ampère, gramme armature dynamo; one 65 volt, 32 ampère, drum armature dynamo; one 65 volt, 12 ampère, drum armature dynamo; one 50 volt, 20 ampère, gramme armature dynamo; one 10 H.P. Griffin gas engine; one 2 H.P. National gas engine; one ½ H.P. National gas engine, mounted with the above 65 volt, 12 ampère, dynamo on the same bed plate; two 5 ampère short arc lamps: two 10 ampère short arc lamps.

Saxby and Farmer; S. E. Railway; Sidney and Barnet.

Sugden, James, exhibit will consist of switches, cut-outs, wall sockets, &c., and screws for connecting purposes.

South of England Electric Manufacturing Company: Electric welding machinery; electric augur twisting machinery; electro motors; dynamos; transformers; engines, and a model of the T.P. system of electrical distribution.

Thatcher, H. W.: Electric railway station indicator, and simplified A.B.C. telegraph instruments.

Vaughan and Brown.

Waygood, R., and Company: Passenger lift, and a dinner lift driven by Siemens motors.

Western Electric Company: Telephones, switchboards, cables, and complete assortment of telephonic apparatus, hotel indicators, police and fire alarms, &c.

Wiggins, F., and Sons.

LEGAL.

Teaven v. Greenock Steamship Company, Limited.—In the Court of Session, Outer House, last week, Lord Kincairney closed the record in an action by Bernard Teaven, dock labourer, Thistle Street, Glasgow, against the Greenock Steamship Company, Limited, for payment of £500. The pursuer was employed by the defenders in the loading of their vessel the *Gulf of Florida*, at the Queen's Dock, Glasgow, on September 25th last. While he was going into the hold the light went out, and the pursuer's hand and leg were seriously injured by coming against iron plates in the dark. He contends that the electric machinery and equipment in use were inadequate and defective. The defenders reply that the light was burning when the pursuer fell, and that the accident was due to his own carelessness. If the light went out that was owing to the fault of the fellow-servant of the pursuer.

A PROTEST.

WE regret that we omitted from the list of Crystal Palace exhibitors the name of the Medical Battery Company, whose wares we have over and over again alluded to in the strongest manner, because an opportunity may thereby have been lost for enabling the exhibitors as a body to vehemently protest against being associated with any such exhibit. We do not know whether the Electrical Trades Section of the London Chamber of Commence, the Crystal Palace authorities, or the engineer to the Exhibition are to blame in this matter, but it is not too much to say that such exhibits should have been rigorously excluded. But perhaps it is not too late, even now, to cancel whatever agreements may have been inadvertently entered into. The electrical profession has at this moment an opportunity which may never arise again of strongly protesting against electropathic belts and contrivances constructed in direct opposition to, or at variance with, the most elementary laws of electricity, and not one of which should be shown under the auspices of this important and influential Exhibition.

The Electric Light in Fleet Street.—The London offices, in Fleet Street, of Messrs. Ed. Lloyd, Limited, the well-known paper makers, are being fitted throughout with the electric light by Messrs. Paterson and Cooper.

NOTES.

January 1st, 1892.—As this issue of the REVIEW should reach our English subscribers on the first day of the new year, we take the opportunity of offering them, and also our foreign supporters, a cordial wish for increased prosperity during 1892. The number contains the index for the expired half-year, which, in itself, offers a fair indication of electrical progress of the past six months, progress, doubtless to be exceeded by the next.

Co-operative Electric Lighting.—Several citizens of the town of Zanesville, O., U.S.A., have formed a small company with the object of supplying themselves with electric lighting at first cost.

An Electric Letter Stamper.—We learn that an electric letter stamper is at present being tried at the Post Office in Washington, U.S.A., in which the time-stamp is altered every minute. Those at present in use are only altered each hour, or at the most each half hour.

A Competition Open.—A prize is offered by the Société des Eaux et de la Dranse, in Switzerland, for the best system for the electrical utilisation of a fall of water. Particulars of the competition may be had from the Secretary of the Société des Ingénieurs Civils, of Paris.

Electricity in German Printing Establishments.—The printing machines of the Berlin journal, *Deutsche Warte*, are now driven by electric motors.

The Electric Light in Bavaria.—It is intended to illuminate the town of Deux Ponts, in Rhenish Bavaria, with the electric light, and the necessary estimates are being drawn out.

The Electric Light in Oxford Street.—The large drapery establishment of Mr. Henry Glave, in Oxford Street, is being installed throughout with the electric light by Messrs. C. E. G. Gilbert & Co.

Hastings Electric Light Company.—A short time ago we published some Notes which reflected on the lighting of the Hastings Company. We have since ascertained that these accounts were exaggerated, and we take this opportunity of modifying the statements then made.

Belgian Telephones.—The Belgian Government has informed the Belgian Telephone Companies of its intention to resume from January 1st, 1893, the working of all the telephone lines in Belgium.

Church Lighting.—The cathedral church of St. Nicholas, Galway (partly of the Norman period), was lighted electrically on Christmas Day for morning service. High candle-power incandescents are mainly used, arranged to give a mean illumination of one candle, at a distance of 1¼ feet for every square foot of floor space. All wires are connected to one switchboard, so that each light can be controlled from the same spot. The ornamental gas standards in choir have been used, the gas burners being replaced by 8 C.P. lamps covered with iced shades. The effect is very pleasing, and the change from gas has given great satisfaction to the congregation. The work was carried out by the Galway Electric Company, from whose central station the current is supplied.

An Electric Lamp Thief.—A thief, who has for a long time, in all probability, been stealing incandescent electric lamps at the Paris theatres, has just been arrested, says the *St. James's Gazette*, by a clever device of the management of the Porte St. Martin. As it was found that a great many lamps had disappeared at that house, the electrical engineer so arranged the fittings that immediately a lamp was removed the electric current sounded an alarm. The man was thus caught as he was making away with a lamp in his pocket, and as he refused his name and address to the police, it is believed that he has a large store somewhere of the stolen articles.

Extension of Bradford Lighting.—We learn that at a recent meeting of the Bradford Town Council it was agreed to direct that all necessary steps be taken for extending the area for lighting by electricity, so as to include the district of Allerton.

Electric Light in Manchester.—It is stated that works for the lighting by electricity of Manchester will commence this month. The Town Council are about to advertise for tenders.

County Council Offices Lighted by Electric Light.—The County Council has accepted Mr. J. D. F. Andrews and Co.'s tender of £1,490.

Gas and the Fogs.—There have been many complaints about the gas during the recent fogs. Some say that street lighting has been in many instances neglected, others that the houses have not had a full supply. We think it is beyond dispute that the gas companies came badly out of the ordeal of last week. Another disagreeable feature of gas lighting has been brought forward, and that is an increase in the price. A few more incidents such as these, and electricity will advance.

The Electric Lighting of Larne.—Messrs. J. E. H. Gordon are the contractors for lighting Larne by electricity. Annoyed at deprecatory newspaper paragraphs concerning the carrying out of the work, they wrote to the council for an expression of opinion. They obtained one, for the reply came that the authorities were dissatisfied at the non-completion of the contract.

Siemens and Halske at the World's Fair.—It is said that Messrs. Siemens and Halske, of Berlin, have applied for 20,000 square feet of space at the World's Fair. It is stated 2,000 horse-power will be required by this firm, and the weight of the exhibit is estimated at 340 tons.

Electric Launches in America.—An American contemporary states that electric launches will be placed on Lake Washington, near Seattle on the Pacific Coast, next spring.

A New Lamp Shield. — The McCreary Electrical Speciality Company, of New York, is making a lamp shield which effectually protects the eyes. The shield is attached to the lamp by a wire, and can be moved to any desired position.

The Gauzentes Miner's Lamp.—Our London contemporary, the *Electrical Engineer*, described in its last issue the Gauzentes Miner's lamp. We should have hesitated to mention this fact, but when it is given as something new we must protest. This lamp, in one form and another, has been appearing and disappearing, like a metamorphosed trap-jumper in a pantomime, for several years, and will no doubt continue to do so while people are willing to finance it.

Market Lighting.—The tenants of the Central Meat, Poultry, Provision, and Fish Markets have petitioned the Grand Markets Committee of the Corporation to give them the electric light. Let us hope that the petition may be successful, for what a boon it would have been during the recent fogs.

The St. Pancras Electricity Loan.—The following tenders were received for the loan of £60,000 to be borrowed on the security of the rates for 42 years:—Preston and Co., 3⅜ per cent. with 11s. per cent. for commission for obtaining the loan. Dagnell and Co., £3 12s. 6d. per cent. Hearts of Oak Benefit Society, 3¾ per cent. Prudential Assurance Society, 3½ per cent. On the proposition of Mr. Sweet, seconded by Dr. Bell, the tender of the last was accepted.

Personal.—Mr. E. R. Dolby informs us that he will retire from the editorship of the monthly journal *Electrical Plant*, after editing the special central station number and the ordinary January issue, 1892, and will then devote his entire attention to his consulting practice.

Electric Light Conductors. — The Chairman of the Elmore Wire Company ought to congratulate himself on having such a simple-minded body of shareholders to address. The idea of electric light contractors using Elmore strip in preference to other high conductivity copper is too transparent, and the Elmore people will find that they will have to compete at market prices, or keep their precious deposit in "the largest shed in Yorkshire."

Electric Lighting for Glasgow Streets.—At a meeting of Glasgow Police Commissioners, on Monday, Councillor Gray reported the proposal to light the principal streets by electricity would be practically taken up. The streets proposed to be lighted were Argyle Street, Jamaica Street, Buchanan Street, Sauchiehall Street, and St. George's Square.

NEW COMPANIES REGISTERED.

Keighley Electrical Engineering Company, Limited. Capital, £10,000 in £1 shares. Objects: To acquire and carry on the business of C. J. Garnett, of South Street, Keighley, and to carry on the business of electrical engineers, suppliers of electric light, &c. Signatories (with 1 share each): J. C. Ickringill, Keighley, Yorks; A. W. Mungeam, 5, Sandland Street, Bedford Row, W.C.; F. J. Currey, 1, Field Court, Gray's Inn, W.C.; J. Smith, Keighley; G. Burr, Keighley; W. Weatherhead, Keighley; H. D. Smith, Keighley; and T. Hird, Keighley. Registered on the 24th ult. without articles of association by Ullathorne, Currey and Villiers, 1, Field Court, Gray's Inn, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Woodhouse & Rawson United, Limited.—The annual return of thiscompany, made up to the 27th Nov., was filed on the 17th ult. The nominal capital is £550,000 divided into 60,000 ordinary and 50,00 preference shares of £5 each. Of these, 55,170 ordinary and 41,118 preference shares are taken up, and upon 34,107 shares £5 per share has been called; upon 5,281, £1 per share; upon 4,045, £2 per share; and upon 34,355, £2 10s. per share has been called, resulting in the payment of £268,163 10s. (including calls paid in advance), leaving £1,630 in arrears. 8,564 ordinary and 9,936 preference shares were issued as fully paid, and £11 10s. has been paid on 3 ordinary and 20 preference, which have been forfeited. Registered office: 88, Queen Victoria Street, E.C.

Gordon Electric Traction Company, Limited.—The annual return of this company, made up to the 9th ult., was filed on the 17th ult. The nominal capital is £2,400 in £10 shares. 206 shares have been taken up, of which 60 were issued as fully paid. Upon 133 of the remainder the full amount has been called, and upon 13 £5 per share has been called and paid, amounting to £1,385. Office at the offices of Messrs. Merryweather & Sons, Greenwich.

Swan United Electric Light Company, Limited.—The annual return of this company, made up to the 8th ult., was filed on the 17th ult. The nominal capital is £1,000,000 in £5 shares, of which 78,949 ordinary and 19,750 fully paid shares have been taken up. Upon the ordinary shares £3 10s. per share has been called and paid, amounting to £279,851 10s. £3,530 has been paid on 1,201 shares which have been forfeited.

Blackpool Electric Tramway Company, Limited.—The annual return of this company, made up to the 12th ult., was filed on the 17th following. The nominal capital is £30,000 in £10 shares, the whole of which have been taken up. Upon 2,850 £6 10s. per share has been called and paid, and the remaining 150 were issued as fully paid. Registered office, Albert Terrace, Blackpool.

Globe Electric Company, Limited.—An agreement made November 30th, 1891, between Sir William Vava-

sour, of Hazlewood, Yorks (called the vendor), and the above-named company, states that whereas by an agreement made November 30th, 1891 (? 1890), between the same parties the company agreed to issue to the vendor 5,500 fully paid shares of £1 each in consideration of the assignment of certain patents, it is now agreed that the company shall, before December 1st, 1891, allot to the vendor or his nominees 5,500 fully paid shares in the company. Registered office, 36, Great James Street, Bedford Row, W.C.

Thetford Electric Light and Power Company, Limited.—The first return of this company, made up to the 30th Nov., was filed on the 14th ult. The nominal capital is £5,000 in £10 shares. 368 shares have been taken up, upon each of which £6 has been called and paid, with the exception of £3. Registered office, St. Nicholas Street, Thetford, Norfolk.

Electric Installation and Maintenance Company, Limited.—At an extraordinary general meeting of the members of this company, held at 4, Great Winchester Street, E.C., on December 3rd, 1891, the following special resolutions were passed, and were duly confirmed at a subsequent extraordinary general meeting held on December 19th, 1891:—(1) That the name of the company be changed from the "Electric Installation and Maintenance Company, Limited," to the "Crystal Palace District Electric Supply Company, Limited." (2) That each of the existing £10 shares be divided into 10 £1 shares. (3) That the existing articles of association of the company be cancelled, and that the articles of association which have been produced to the meeting and signed by the chairman, be the regulations of the company and be registered accordingly. The new articles of association were filed with the above on the 23rd ult.

Liverpool Electric Supply Company, Limited.—At extraordinary general meetings of the above company, held on the 7th and on December 23rd, 1891, respectively, the subjoined special resolutions were duly passed and confirmed:—(1) That in accordance with Section 9 of the Liverpool Electric Lighting Order, 1889, further share capital of the company, of the nominal value of £40,000 be, and the same is hereby appropriated as a separate capital for the purpose of the undertaking thereby authorised in respect of the district comprised in Schedule A of the said order. (2) That in accordance with Section C of the Liverpool Electric Lighting Order, 1891, share capital of the company of the nominal value of £20,000 be, and the same is hereby appropriated as a separate capital for the purpose of the undertaking authorised by that order; and (3) is for the changing of the articles of association of the company which were filed on the 24th ult. with the above. Registered office, 15, Highfield Street, Liverpool.

National Telegraph Works Company, Limited.—The registered office of this company is situate at the National Telegraph Works, 109, Wainwright Street, Aston, near Birmingham.

BUSINESS NOTICES, &c.

The India-rubber, Gutta Percha and Telegraph Works Company, Limited, Silvertown.—This company has been fairly busy in every branch throughout the year, and in the electrical departments some important orders have been carried out. The cable department laid along the west coast of South America 1,750 knots of submarine cable for the Central and South American Telegraph Company. Over 1,600 knots of cable have been made and laid along the coast of Brazil for the Western and Brazilian Telegraph Company. Orders have also been executed for cable for the Post Office, the India Office, and various foreign governments, and about 1,100 knots of a cable to be laid next year between West Africa and Brazil have already been manufactured. The cable department has, in addition, delivered a large quantity of torpedo and electric light cable for shipping orders. For low tension house lighting cables and wires, the demand still increases, and for high tension distribution considerable lengths have been manufactured for the Metropolitan Electric Supply Company, the House-to-House Electric Supply Company, the City of London Electric Company. Newcastle-on-Tyne and other towns in England have been large consumers. The company's French factory has filled several orders for the lighting of Paris, Madrid, Barcelona, Tours, Havre, &c. The Admiralty, as a result of past experience, has decided to again adopt India-rubber insulation, and the Silvertown Company, in addition to the Government contract for the year, has obtained a number of orders from the various firms carrying out Admiralty contracts. The instrument department, besides railway, Post Office, and Admiralty work, has executed a number of shipping orders for telegraph and torpedo instruments, and has supplied the whole of the new station switchgear for the London Electric Corporation. The battery department has throughout the year been full of orders, especially for Leclanché cells, which have been supplied in large numbers to Government, and to railway and supply companies. In the electric light department a fair quantity has been done, including the supply of dynamos and the fitting up of electric light and signal gear on a number of H.M. ships, amongst others the *Blenheim*, *Blake*, *Royal Sovereign*, *Grafton*, *Theseus*, *Repulse*, and *Empress of India*. Installations of electric light in factories, mills, mines, and private houses have also been carried out, and large numbers of complete sets of dynamos, cables, fittings, &c., for installation abroad have been delivered. In transmission of power, an important order has been executed for a tramway on the continent, comprising eight cars, which have been in operation for the whole of the summer season. The results obtained are so satisfactory, that an additional order has been received for the equipment of six 25-H.P. cars, and for the supply of necessary machinery at the station for this extension. In the smaller electrical branches there has also been a good demand.

J. H. Holmes and Company.—The *employés* of Messrs. J. H. Holmes & Co. held their fourth annual dinner last Saturday, the 26th inst., at the Crown Hotel, Newcastle-on-Tyne. About fifty persons sat down to dinner, which was served in a manner which reflects credit upon the committee and others responsible for the *menu*. After dinner a most enjoyable programme of music, vocal, instrumental, &c., was listened to, and in response to the toast "The Firm," Mr. J. H. Holmes gave a very interesting account of the evolution of the business of J. H. Holmes & Co. The firm was established in 1883, and they made their first dynamo, he said, in 1885, and have recently heard that it was still working very well. The first ship lighted on the Tyne by electricity was lighted by his firm. The fame of the "Castle" dynamo really commenced at the Newcastle Exhibition in 1887, and in the same year the firm entered their present premises, which in two years later were extended to double the size. At the present time over 500 dynamos bearing this name are at work, and the 624th machine is now being built. Mr. Holmes commented upon the good feeling which existed between the firm and its *employés*, and expressed the wish that this might long continue. Mr. Holmes was frequently applauded during the course of his remarks, and at the conclusion the whole company joined in the customary chorus, "For he's a jolly good fellow." The toast to the "Electrical Engineers" was responded to by Mr. Broadbent (the outside manager), who gave a brief summary of the year's work. He remarked that during the year the firm had completed over 90 installations, including ships, collieries, hotels, houses, &c., and had fixed over 11,500 lamps. The total number of dynamos erected on these installations was 95, having an output of 13,605 lamps of 60 watts each, or 816,300 watts. The number of dynamos made up to date during the year was 125, having an output of 2,650,000 watts. The meeting broke up at 11 o'clock with the familiar "Auld Lang Syne."

Paterson and Cooper.—Messrs. Paterson and Cooper have been well employed during the whole of the year, and exceedingly busy during the latter part. As in previous years, ship lighting has furnished a considerable portion of the business, and among the vessels fitted up in 1891 have been the *Nottingham*, *Staveley*, *Leicester*, and *Lutterworth*, new steamers of the Manchester, Sheffield, and Lincolnshire Railway Company; the *City of London*, *City of Agra*, *City of Khios*, *City of Edinburgh*, and *City of Dublin*, belonging to G. Smith and Sons' City Line; *St. Nicholas* and *St. Sunniva*, belonging to the North of Scotland Orkney and Shetland Company; also the *America*, *Berlin*, *Furnessia*, *Killarney*, *Empress of the East*, and several others, including the steam yachts *May*, *Pathfinder*, and *Hermione*. The firm will have presently on hand the lighting of steamers for the Allan Line, for the General Steam Navigation Company, and for the Clyde Shipping Company. In all manufacturing department the business has been good. The dynamos have averaged much larger sizes than in previous years, mainly on account of a large number being directly coupled to the driving engines. For machines of large output coupled to double-acting engines, the multipolar design is adopted, both Gramme and drum windings being used for the armatures according to circumstances. In arc lamps a good business has been done, a large number having been sold for use on alternating as well as on direct current circuits. The sales in measuring instruments have been well kept up, and the trade in switchboards, fittings and accessories has considerably increased. During the year complete installations have been erected at the Lancaster Waggon Company's works, at Bullionfields Paper Mills, Invergowrie, at the residence of G. Peters, Esq., "High Elms," Watford, and at "Corona," Broughty Ferry, the residence of R. A. Mudie, Esq., the well-known shipowner. Installations of arc lamps have also been completed at the shops of Mr. Lipton, in Dublin, Birmingham, Southampton, Deptford, and London (Edgware Road). Of the wiring of private houses for supply from the various supply companies mains the firm has had a good share, while among the large establishments wired and fitted may be mentioned Messrs Combe's brewery, Messrs. Lambert and Butler's warehouse, and the St. George's Club, Hanover Square. The firm has several contracts still in hand, the largest being the lighting of the *Daily Chronicle* and *Lloyd's News* offices in Fleet Street, and the Refrigeration Stores and Wharf of Messrs. Nelson and Company at Lambeth. The former is being wired for 800, and the latter for 1,600 16-C.P. lamps, and both installations will include direct-coupled dynamos and engines complete. For the *Daily Chronicle* offices the dynamos are two in number, with 24-inch Gramme armatures, running at 300 revolutions in a

4-pole field, and directly coupled to vertical engines, 13½-inch cylinder by 10-inch stroke, made by J. and H. Gwynne. For Nelson's Wharf the dynamos, two in number, are also 4-pole, and have 25-inch drum armatures, running at 200 revolutions, directly coupled to double-crank compound engines. The engines are made by Messrs. J. and H. Gwynne, for whom the installation is being carried out, and have 8½-inch and 16-inch cylinders, with a stroke of 14 inches.

The Electrical Standardising, Testing, and Training Institution. Chairman: The Right Hon. the Earl of Crawford, K.T.; Principal, H. E. Harrison, B.Sc., M.I.E.E., F.C.S.; Secretary, P. A. Latham, M.A. During the earlier part of the year some time had to be spent fitting up the new premises—Faraday House, Charing Cross Road—under the superintendence of the heads of the various sections. The standardising and testing departments have had continuous work since they were opened; and as manufacturers and others are finding that their instruments can be standardised and calibrated more efficiently than at their own works, this branch of the business steadily increases, though some firms prefer hiring a private room and doing their own work, the institution supplying apparatus and current. A good deal of work has also been done by experimenters who rent the private rooms and borrow the apparatus as they require it. Much has been done in the direction of inspecting and reporting upon private installations, testing meters, &c., in cases where disputes have arisen between householders and their contractors or supply companies. Dynamo machines, steam engines, and apparatus generally have also been inspected at the manufacturers to see if they fulfil the specifications, but this work has been chiefly done for agents who are sending plant abroad. Indeed, the necessity of the new departure made when the institution was founded has been clearly shown by the connection already made. In the training department some 50 names are on the books, and it is satisfactory to learn that the companies and firms in affiliation with the institution have already drawn upon it for assistant engineers; the companies usually keeping those apprentices who have been sent them for the purpose of being practically trained, and who have shown themselves specially apt for their work. The forthcoming competition for the scholarships and exhibitions seems likely to be large.

Diaries, Almanacs, &c.—We have received neat blotting pads, with diaries attached, from the Electric Power Storage Company and Crompton and Company, and date remembrancer from Messrs. Willcox & Co.

Catalogues.—We have received catalogues from Mr. Ronald A. Scott and Messrs. Dorman and Smith.

Partnership.—Sir Frederick Bramwell informs us that from to-day, Mr. H. Graham Harris, who has for so many years been his principal assistant, will become his partner, and that the business heretofore practised by him at Westminster will be continued under the style of "Bramwell and Harris," to whom it is requested all letters on matters of business should be addressed.

CITY NOTES.

Elmore's Patent Copper Depositing Company, Limited.

THE directors in their second annual report and statement of accounts to June 30th, 1891, state that they have pleasure in submitting to the shareholders their report, and in congratulating them on the satisfactory technical and commercial prospects of the company. They also submit the accompanying statement of the accounts for the year ending June 30th, 1891, which shows a credit balance at the end of the preceding year of £77,825 1s. 4d., from which two dividends of 10s. each, making £1 on each £2 share, were paid.

It will be seen that the accounts show credit balances on June 30th last of £14,261 17s. 10d., made up of £5,000 royalties on copper sheets received in advance, £8,558 7s. premiums and profit on land, and balance of profit and loss of £703 10s. 10d., a satisfactory result, considering that the company had only been able to manufacture small quantities of articles at the date of the making up of the accounts—work on a large commercial scale not having been then commenced.

The directors have much satisfaction in announcing the successful completion of the 20-ton plant, and thus the programme of work set forth in the prospectus has been carried out. The cost of manufacture has also now been found to be only about ½d. per pound weight of finished goods—that is to say, about one-half the cost that the directors estimated in the prospectus, whilst the statements as to the technical features of the process have been entirely proved. The directors are the more gratified in being able to refer to these results, as, though the application of the essential part of the Messrs. Elmore's invention has remained unchanged, various difficulties connected with the mechanical details of the process, inseparable from the commercial development of all important inventions, were encountered. These caused some considerable delay.

The managing director reports that all these difficulties have now not only been successfully overcome, but that they have led to the taking out of additional patents of great value, which will have the important practical effect of prolonging the monopoly of the invention. Foremost amongst these may be mentioned the patent for the manufacture of sheet copper, the license to work which on a royalty, which will prove a valuable source of income to this company, has been granted to Elmore's Wire Manufacturing Company.

The directors desire specially to draw the attention of the shareholders to the purchase of the Haigh Park Estate, Leeds, consisting of 127 acres of freehold land, on a portion of which site the company's works have been erected.

The purchase of this property was rendered advisable by the impossibility of acquiring portions of it required for the purposes of the company and its future extensions, except at the price of £2,000 per acre, whereas the price actually paid for the whole estate was only £534 per acre, including all expenses. The land is within half a mile of the borough of Leeds, connected by sidings with the Midland and Great Northern Railways, and has a wharf on the Aire and Calder Canal, which latter bounds the estate for three-quarters of a mile. It has an extensive frontage to the Pontefract high road, and is in close proximity to cheap coal supplies. The new line of the South Leeds Junction Railway, for which a Bill has been lodged in Parliament, is planned to run through the estate. These advantages and improvements have resulted in what the directors foresaw, viz., a great increase in the value of the land, which must make the purchase a valuable acquisition for the company. Negotiations have already taken place for the sale of portions at a considerably higher price than that paid. A plot of 13 acres has been disposed of at £1,000 per acre to Elmore's Wire Company, and this price, whilst yielding an excellent profit to your company, is nevertheless 50 per cent. below the price demanded for this plot by the former owner, and the directors are advised that they will be enabled to dispose of the whole of the land not required for the purposes of the company at a similar profit.

The completion of the 20-ton plant was lately marked by an invitation to the larger shareholders to see it at work, and over one hundred, from various parts of the country, availed themselves of this invitation, and they expressed the greatest satisfaction at what they saw.

The Messrs. Elmore have made a joint report to the board as to the earning powers of the works. This report is of a most important character and is enclosed herewith.

By this report it will be seen that the profits of the works as now completed are put at over £45,000 per annum, being 30 per cent. upon the present capital of the company, whilst when the time comes for doubling the output to 40 tons per week the profits will be increased to over £95,000 per annum, equal to nearly 50 per cent. upon the increased capital that will then be required.

These returns, extraordinary as they may seem, Mr. Elmore fully believes will be exceeded by actual results; and considering that the report takes no account of important sources of profit such as sales of licenses, recovery of precious metals, and special kinds of work, the directors see no reason to doubt the conclusions therein contained.

From the numerous testimonials from important firms, copies of some of which have already been despatched to the shareholders, it has been shown that the goods supplied to customers have given complete satisfaction, and of this the numerous repeat orders, and the offers of a very large additional business at remunerative prices, are a still better and more practical proof.

The directors desire, in conclusion, to record their belief that, now that the company may be considered to have entered upon its legitimate manufacturing business on a commercial scale, the shareholders will find that in the Elmore invention they possess a process that will be a continued source of profit, increasing from year to year, as the quality of the goods produced becomes more and more known.

The directors who retire are Sir John Morris, Mr. Atkinson, and Mr. Carson; the former, owing to continued ill-health, does not seek re-election; the latter two are eligible, and offer themselves for re-election.

The auditors, Messrs. Price, Waterhouse & Co., also retire, and offer themselves for re-election.

Mr. Wm. Elmore, the managing director, submits the following report:—

As requested, I beg to hand you my estimate of the approximate annual profits to be earned by the 20-ton per week plant, now complete and in operation at the above works, as follows:—

Proceeds of 20 tons of copper tubes and other articles, per week, which, per annum (of 50 weeks), is 1,000 tons, equal to 2,240,000 pounds weight, at 1s. per pound ... (1s. 1¾d. per pound weight of copper being the average selling price calculated upon the total of the orders now on the company's books being executed).		£112,000
It is important to note that for every 1d. per pound over 1s. added to the selling price of tubes manufactured by this company, on a basis of 20 tons per week, over £9,000 per annum will be added to the profits.		
Less cost of production.		
Deduct cost of 1,081 tons of rough copper bars, at £50 per ton ... ... (Market price of Chili bar to-day is £44 10s.)		54,050
		£57,950
Equal to about ¾d. per pound weight for cost of manufacture: Coals consumed, 80 tons per week, say 4,000 tons for 50 weeks at 10s. per ton... ...	£2,000	
Labour £40 per week is, per an. of 50 weeks	2,000	
Oil, chemicals, and sundries, say £10 per week is, per annum of 50 weeks... ...	500	
Contingencies, at £10 per week	500	
		5,000
		52,950
Allow for depreciation of plant		2,500
Net profit		£50,450

Upon the basis of actual cost at these works, and experience gained on the practical scale to date, I have added to every item from 25 per cent. for the purpose of meeting any contingency, and being perfectly safe. You will be pleased to note that the cost of manufacture is about ¼d. per pound, my original estimate being 1d. per pound. I have made a deduction for wear and depreciation at the rate of 50 per cent. of the total working expenses. Without taking credit for gold and silver recovered from the raw copper, or for the large extra profit to be derived from special kinds of work which the company's process enables it to take at from 2s. 6d. to 5s. per pound (superseding hand labour at a much greater cost), the net profit equals over 33 per cent. on £150,000, the issued capital of the company.

Owing to the high quality of the company's manufactures, and the demand for them indicated by the largely-increasing number of applications for quotations and offers of work, it will be necessary to increase the existing plant, to double the present plant of 20 tons per week and make it equal to 40 tons per week.

The profits will then be, on the above basis, for 20-ton per week plant	£50,450
Add for double the production	50,450
	£100,900

There will be required for this extra production £20,000 for plant and £30,000 for working capital; this will make the total capital issued £200,000, on which, on the above basis of profit, the return would be over 50 per cent. per annum.

Moreover, there is no reason for taking 40 tons per week as the limit of production. For instance, the French Elmore Company's works, which are nearly completed, are upon a scale of production of 80 to 100 tons per week, and the general manager, M. Sécretan, writes that already he sees that the demand will enable the company to double or even treble the plant within a short period.

From the above facts it will be seen that in the Elmore invention the company possesses a property not paralleled in the whole range of industrial investments, and now that the delay in getting the 20-ton per week plant at work—delay incidental to all new discoveries—has been overcome, the extraordinary earning power of the company will be appreciated.

P.S.—I have not included in the above estimates the cost of the London and Leeds office expenses, salaries, and directors' fees, amounting in all to, say, £5,000 per annum, although up to the present time these expenses have only slightly exceeded one-half that sum.

BALANCE SHEET, June 30th, 1891.

Dr.	£ s. d	£ s. d.
To Nominal Capital—		
100,000 shares of £2 each ...	200,000 0 0	
Of which there have been issued 75,000 shares	150,000 0 0	
Less calls not yet due	6,500 0 0	
		143,500 0 0
„ Mortgages on land and interest to June 30th, 1891		43,371 16 8
„ Sundry creditors		4,744 17 2
„ Royalties received in advance on copper sheet license		5,000 0 0
Reserve Account—		
Premiums received on new shares	2,507 10 0	
Profit on 13 acres of land sold ...	6,050 17 0	
	8,558 7 0	
Profit and Loss—		
Balance as per account	703 10 10	
		9,261 17 10
		£205,878 11 8

Cr.	£ s. d	£ s. d.
By purchase of 127 acres of land ...	67,887 16 8	
Less proportion of cost and expenses of 13 acres sold	6,949 3 0	
		60,938 13 8
„ Buildings, sidings, &c.	8,011 18 8	
„ Additions during the year ...	3,512 16 10	
		11,524 15 6
„ Plant, machinery, &c., as at June 30th, 1890	11,339 1 1	
„ Additions during the year ...	11,110 15 10	
		22,449 16 11
„ Patents as at June 30th, 1890 ...	80,000 0 0	
„ Additions and expenses during the year	702 17 6	
		80,702 17 6
„ Sundry debtors	1,899 14 5	
„ Ordinary and founders' shares in Elmore's Wire Manufacturing Company, Limited, at cost ...	11,953 9 0	
		13,853 3 5
„ Stocks in trade		7,807 0 6
„ Fixtures, furniture, and fittings ...		947 8 5
„ Cash at bankers and in hand ...		7,654 15 9
		£205,878 11 8

PROFIT AND LOSS ACCOUNT for the year ending June 30th, 1891.

Dr.	£ s. d.
To Advertising and exhibition expenses	168 14 9
„ Travelling expenses and general charges	251 12 9
„ Rent, rates, and insurance	349 4 4
„ Balance of income-tax	103 12 3
„ Stationery, printing and postages	306 10 6
„ Maintenance of patents, legal and professional charges	358 14 9
„ Maintenance of plant and repairs	543 9 8
„ Directors' fees	1,452 19 6
„ Salaries	2,317 17 5
„ Balance carried to balance-sheet	703 10 10
	£6,556 6 9

Cr.	£ s. d	£ s. d.	£ s. d.
By Balance, June 30th, 1890		77,825 1 4	
Less appropriated as under—			
Interim dividend of 10s. per share (less tax) paid April 18th, 1890	£34,125 0 0		
Second dividend of 10s. per share (less tax) paid July 29th, 1890 ...	34,125 0 0		
Income-tax on the latter	875 0 0		
Preliminary expenses	1,850 0 0		
Directors' percentage of profits to June 30th, 1890	3,930 13 1		
		74,905 13 1	
			2,919 8 3
„ Balance of factory account, including amount received from Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, for laboratory and experiment expenses			1,398 17 6
„ Sales of licenses...			1,581 0 0
„ Interest and discount			417 14 7
„ Transfer fees, &c.			239 6 5
			£6,556 6 9

We have examined the above balance-sheet and profit and loss account with the books and vouchers of the company, and find the same to be correct.

PRICE, WATERHOUSE & Co.

44, Gresham Street, E.C, *December 17th*, 1891.

The second annual meeting of this company took place at the Cannon Street Hotel, on Wednesday last, Mr. J. J. Atkinson in the chair.

The SECRETARY (Mr. J. Shurmer) having read the notice convening the meeting,

The CHAIRMAN said—Gentlemen, there is an old saying, "Good wine needs no bush," and I think that after the report we have been able to send you, you will not think it necessary for me to address you at any great length. You will see by the report that all the preliminary difficulties have been entirely overcome, and that we are now ready to go forward and earn money for you, and pay you handsome dividends. When we double, treble, and even quadruple our present plant, which we shall in due course have to do, those dividends will be so increased that I honestly believe you will have a chance of getting returns of cent. per cent. upon your investment in the capital of the company. You will be glad to hear that our difficulty is not to take orders, but to know what orders to refuse out of the great number on offer. As you know, there is a French Elmore Company formed to work the process in France, and last week I had the honour of being invited to see their works. These works are now in operation, and though designed for an output of 90 tons a week already, their manager reports that he can sell double their proposed output. From these remarks, and the figures which Mr. Elmore will give you, you will see there is not the slightest question about our getting a sufficiency of orders. I have no dividend to declare, but I can state to you, gentlemen, that we are to-day actually earning a considerable one—there is £500 profit in our tanks for this week—and I myself expect that before very long we shall be able to send each of you a nice little cheque as the result of what we are earning. I should like to say a few words about our investment in land referred to in the report. As you are aware, we are not a land company, and in the ordinary course we should only have bought sufficient land for our own immediate requirements, but being myself an adjacent landowner, and knowing well its value in the neighbourhood of the rising town of Leeds, and finding that we should have to pay some-

thing like £2,000 an acre for any extension of our works, and then be exposed later on, if we wished to further increase them, to still larger demands, I strongly urged the board to make the purchase of the whole estate at Haigh Park. This the company did not see its way to do at the time, and Mr. William Elmore very pluckily stepped in and bought the property. Later on, when the land had increased in value, and we saw the bargain that Mr. Elmore had, we readily accepted his generous offer to let the company take over the purchase at the original price. Since that time, as we have mentioned, the value of the land has greatly increased, and I will read you a letter from a gentleman who is acknowledged in Leeds to be the greatest authority on the value of land in that neighbourhood. He writes as follows:—

"Aire and Calder Navigation, Leeds,
"*December 26th*, 1891.

"My dear Atkinson,—You ask me my views in regard to the Haigh Park Estate, lately belonging to Lord Stourton, and now acquired by a company with which I believe you are connected.

"It is a valuable property, and in the near future must become exceedingly so, as any considerable extension in the manufacturing industries of Leeds must necessarily be in that direction, for there is no land so suitable or now available.

"I do not know whether you are aware of the fact that the proposed South Leeds Junction Railway of the coming session passes through the estate on its western side. This, if passed by Parliament, will enhance the value of the estate, although it is already exceptionally situate by having the Aire and Calder Navigation, with its easy connection on one side, and a junction with the Midland Railway on the south side.

"Altogether, I think the company have done well to acquire the estate, and especially if they can afford to wait awhile before realising.

"Yours sincerely,
"W. H. BARTHOLOMEW."

In addition to this and the other advantages set out in the report, the Midland Railway Company have not only agreed to spend a considerable sum in improving the means of communication with the estate, but have also arranged, later on, to build a passenger station contiguous to our property. In justice to Mr. Elmore, I must say that he has worked like a Trojan, and even if he has been slow in getting our company to its present prosperous position, he has, nevertheless, given one of the greatest possible proofs of his zeal for the company, and his interest therein, by giving up his purchase precisely on the same terms as he had procured it. If he had been a stranger, there would have been nothing wrong in his asking £25,000 profit on the price, and then we should have had a bargain. In fact, if at the end of a year or two the company do not find that they have made a splendid bargian, I shall be very glad to take it off their hands. I think, therefore, that our thanks are very much due to Mr. Elmore for the excellent position he has put us into in that respect, and I have no doubt that, before we part, you will favour him with a vote of thanks instead of a cheque for the profit he might otherwise have made. Three members of the board retire. Sir John Morris is not allowed by his physician to offer himself for re-election, but possibly he may be able to join us again later on. With regard to the other two members, Mr. Carson and myself, I may say that Mr. Carson, from his knowledge as a director of the Cape Copper Company, of which he was originally the manager, has been of great assistance, and is one of the four largest holders of our shares. I, myself, have every confidence in the great value of this invention, and have had ever since it was only an idea in the mind of the inventor. I hold over 8,000 shares in the company, and have upwards of £40,000 in the various Elmore companies, and have never sold a single share, even when they were at £8 each, which figure I believe they will soon be at again. On the contrary, I have been steadily increasing my holding. In fact, I may say the directors of your company are by far the largest holders in the company, holding, I believe, nearly a third of the issued capital. Gentlemen, I now beg to move, "That the report and statement of accounts for the year ending June 30th last be passed and adopted."

The following report of Mr. Elmore, the managing director, was then read by the Chairman:—

"I beg to confirm my report of November 30th last, and the gratifying results I was then able to foreshadow, and to state that our experience since more than bears out my figures.

"Since my previous report of June 1st, 1891, the new copper mandrel has proved to be all that I then claimed for it, and it even exceeds my expectations, simplifying the process immensely.

"I send you the two tubes recently tested by an independent expert, one made by our electro-burnishing process and the other one a brazed tube of the best ordinary make. The result of the trial you already know of, viz., that the Elmore tube turned out to be not only more than three times as strong as the best brazed tube, but of such high uniform quality that, although the testing machine had to be specially made, the machinery actually gave way two or three times in the course of the tests, and had to be strengthened to meet the great resisting power of the Elmore tube. From this it will be seen that the company will practically have a monopoly of steam pipes of large diameter, and that marine engineers will at once abandon the use of brazed copper pipes, which have given them so much trouble of late by bursting under the high steam pressures used in the triple and quadruple expansion engines, some fifty or sixty lives having been lost during the present year from this cause; and I may state that we have already received some important communications and assurances to this end. The difference in the two kinds of tubes cannot be better expressed than in the words of the eminent engineer who made the test, as follows:—

"'I beg to inform you that I have to-day witnessed the bursting of two experimental copper pipes, one made by your electro-burnishing process, the other, an ordinary brazed tube, made by a first-class coppersmith in Leeds.

"'The first pipe is 5 feet 6 inches long, 9½ inches in diameter inside, and ½-inch thick. The pressure was applied to the inside of this pipe by means of a three-throw hydraulic pump driven from the shaft in the shop; up to a pressure of 1,000 lbs. per square inch the pipe showed no signs of distress. At a pressure of 1,176 lbs. to the square inch the pipe commenced to expand in the middle uniformly, until this part of it became ⅝-inch larger in diameter than the other part, and water commenced to pass from four separate points almost opposite to each other, showing that the metal was stretching uniformly, and that the pipe was almost on the point of bursting. The pressure was again increased until 1,456 lbs. to the square inch was reached, when the pipe stretched at this part from 9½ inches outside diameter to 11 inches, and at this pressure it burst, opening out in the centre of the pipe for a distance of about 10 inches, the fracture being 1¼ inches wide.

"'The pipe was afterwards measured, and it was found that although at the moment of fracture its diameter was 11 inches and the metal had stretched uniformly to that extent, still when the pressure was released the pipe returned to a diameter of 10⅝ inches.

"'The next pipe, that is the brazed one, was 9 inches diameter, also 5 feet 6 inches in length, and ⅛ inch thick. At a pressure of 120 lbs. to the square inch, one end of the pipe swelled to the extent of ½ inch in diameter for a distance of about 12 inches from the flange, and as the pressure was increased to 300 lbs., the opposite ends swelled in like manner, which clearly proves that in heating the copper to flange it at each end its ultimate strength had been greatly reduced. The pressure was again increased to 448 lbs. to the square inch, when the pipe burst at one end about 12 inches from the flange through the brazed joints, thus demonstrating that the electro-burnished pipe, although ½ inch larger in diameter than the brazed pipe, was 3½ times stronger, and further demonstrates that owing to the great ductile properties possessed by the electro-burnished copper which admits of its being flanged without being heated, enables pipes of this description to be constructed of a uniform strength throughout.'

"It is important to notice that the Elmore tube was flanged (in the ordinary way by an ordinary workman) without annealing, thus preserving to the metal its whole original strength, and avoiding all possible chance of deterioration of the metal by overheating, owing to want of skill or carelessness on the part of the workmen. As showing the rapidity of the growth of our trade, and the favour in which our goods are held by those who have tried them, I would state that we have already, during the last two months, added no less than 130 customers to our list, comprising some of the best firms in the country.

"We have executed 342 orders, and have to-day more orders offered than we can possibly execute.

"Further, one large buyer has given 16 repeat orders; one has repeated orders 14 times; two have repeated orders 12 times each; three have repeated orders 11 times each; two have repeated orders nine times each; five have repeated orders seven times each; three have repeated orders five times each; seven have repeated orders four times each; ten have repeated orders three times each, and an aggregate of 224 repeat orders have been received from a number of our customers, representing about 40 per cent. of the total names upon our books.

"We have on hand orders and offers of orders at prices above those that I estimated in my last report, which will far more than fill our capacity for a long time to come. In addition, since the 20-ton plant was started, we have received specifications and sent out quotations in reply to inquiries for 1,581,669 lbs., or over 700 tons of copper tubes for various purposes, besides a large amount of copper to be deposited upon rams and and other expensive articles, from which to draw our orders and keep our tanks constantly employed.

"The following extracts from letters received during the past few days will be of considerable interest:—

"'Our opinion is that between copper printing rollers and steam pipes alone our district should be capable of absorbing from 50 to 60 tons per week.'

"'All the other conditions such as prices, terms, &c., being equal, we do not see why you should not secure the bulk of the business to be done in our district; but, as you wish to have a safe figure for a definite calculation, we should certainly undertake to dispose of not less than 20 tons of goods referred to, in our district.

"'The results of the bursting tests go to still further prove the excellence of your copper and the bursting pressure—viz., 1,456 lb. per square inch for your pipe, against 448 lb. for brazed pipe, are so wide and absolutely convincing, as to leave no question as to comparative quality.'

"'Since I had the pleasure of seeing you in Leeds, I have made inquiries from the various shipbuilding and engineering ports in the kingdom, as to the weight of copper steam and feed pipes used per year in marine engineering, and I find that the consumption is from 3,600 to 4,000 tons per annum (this includes pipes used for Government vessels as well as vessels built for the mercantile marine), and they range in size from 2 inches in diameter to 12 inches.'

"'Do you propose making copper rollers for calico printing purposes. There is a demand of from 35 to 50 tons per week for these'."

"The above statements are with regard to what we have accomplished in the ordinary manufactures.

"I further have pleasure to officially inform you that another stage in the realisation of the promises that I have made has been reached, which, with the exception of the delay in actual completion, have been more than borne out in every case. This important step is the satisfactory production of a copper cartridge-case, the value of which may be gathered from the fact that it means the successful appli-

Upon the basis of actual cost at these works, and experience gained on the practical scale to date, I have added to every item from 25 per cent. for the purpose of meeting any contingency, and being perfectly safe. You will be pleased to note that the cost of manufacture is about ¼d. per pound, my original estimate being 1d. per pound. I have made a deduction for wear and depreciation at the rate of 50 per cent. of the total working expenses. Without taking credit for gold and silver recovered from the raw copper, or for the large extra profit to be derived from special kinds of work which the company's process enables it to take at from 2s. 6d. to 5s. per pound (superseding hand labour at a much greater cost), the net profit equals over 33 per cent. on £150,000, the issued capital of the company.

Owing to the high quality of the company's manufactures, and the demand for them indicated by the largely-increasing number of applications for quotations and offers of work, it will be necessary to increase the existing plant, to double the present plant of 20 tons per week and make it equal to 40 tons per week.

The profits will then be, on the above basis, for 20-ton per week plant	£50,450
Add for double the production	50,450
	£100,900

There will be required for this extra production £20,000 for plant and £30,000 for working capital; this will make the total capital issued £200,000, on which, on the above basis of profit, the return would be over 50 per cent. per annum.

Moreover, there is no reason for taking 40 tons per week as the limit of production. For instance, the French Elmore Company's works, which are nearly completed, are upon a scale of production of 80 to 100 tons per week, and the general manager, M. Sécretan, writes that already he sees that the demand will enable the company to double or even treble the plant within a short period.

From the above facts it will be seen that in the Elmore invention the company possesses a property not paralleled in the whole range of industrial investments, and now that the delay in getting the 20-ton per week plant at work—delay incidental to all new discoveries—has been overcome, the extraordinary earning power of the company will be appreciated.

P.S.—I have not included in the above estimates the cost of the London and Leeds office expenses, salaries, and directors' fees, amounting in all to, say, £5,000 per annum, although up to the present time these expenses have only slightly exceeded one-half that sum.

BALANCE SHEET, June 30th, 1891.

DR.	£ s. d	£ s. d
To Nominal Capital—		
100,000 shares of £2 each ...	200,000 0 0	
Of which there have been issued 75,000 shares	150,000 0 0	
Less calls not yet due	6,500 0 0	
		143,500 0 0
„ Mortgages on land and interest to June 30th, 1891		43,371 16 8
„ Sundry creditors		4,744 17 2
„ Royalties received in advance on copper sheet license		5,000 0 0
Reserve Account—		
Premiums received on new shares	2,507 10 0	
Profit on 13 acres of land sold ...	6,050 17 0	
	8,558 7 0	
Profit and Loss—		
Balance as per account	703 10 10	
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CR.	£ s. d	£ s. d
By purchase of 127 acres of land ...	67,887 16 8	
Less proportion of cost and expenses of 13 acres sold	6,949 3 0	
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„ Buildings, sidings, &c.	8,011 18 8	
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		11,524 15 6
„ Plant, machinery, &c., as at June 30th, 1890	11,339 1 1	
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„ Patents as at June 30th, 1890 ...	80,000 0 0	
„ Additions and expenses during the year	702 17 6	
		80,702 17 6
„ Sundry debtors	1,899 14 5	
„ Ordinary and founders' shares in Elmore's Wire Manufacturing Company, Limited, at cost ...	11,953 9 0	
		13,853 3 5
„ Stocks in trade		7,807 0 6
„ Fixtures, furniture, and fittings ...		947 8 5
„ Cash at bankers and in hand ...		7,654 15 9
		£205,878 11 8

PROFIT AND LOSS ACCOUNT for the year ending June 30th, 1891.

DR.	£ s. d
To Advertising and exhibition expenses	168 14 9
„ Travelling expenses and general charges	251 12 9
„ Rent, rates, and insurance	349 4 4
„ Balance of income-tax	103 12 3
„ Stationery, printing and postages	306 10 6
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„ Maintenance of plant and repairs	543 9 8
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„ Salaries	2,317 17 5
„ Balance carried to balance-sheet	703 10 10
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CR.	£ s. d	£ s. d
By Balance, June 30th, 1890	77,825 1 4	
Less appropriated as under—		
Interim dividend of 10s. per share (less tax) paid April 18th, 1890	£34,125 0 0	
Second dividend of 10s. per share (less tax) paid July 29th, 1890 ...	34,125 0 0	
Income-tax on the latter	875 0 0	
Preliminary expenses	1,850 0 0	
Directors' percentage of profits to June 30th, 1890	3,930 13 1	
	74,905 13 1	
		2,919 8 3
„ Balance of factory account, including amount received from Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, for laboratory and experiment expenses		1,398 17 6
„ Sales of licenses...		1,581 0 0
„ Interest and discount		417 14 7
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We have examined the above balance-sheet and profit and loss account with the books and vouchers of the company, and find the same to be correct.

PRICE, WATERHOUSE & Co.

44, Gresham Street, E.C, *December 17th*, 1891.

The second annual meeting of this company took place at the Cannon Street Hotel, on Wednesday last, Mr. J. J. Atkinson in the chair.

The SECRETARY (Mr. J. Shurmer) having read the notice convening the meeting,

The CHAIRMAN said—Gentlemen, there is an old saying, "Good wine needs no bush," and I think that after the report we have been able to send you, you will not think it necessary for me to address you at any great length. You will see by the report that all the preliminary difficulties have been entirely overcome, and that we are now ready to go forward and earn money for you, and pay you handsome dividends. When we double, treble, and even quadruple our present plant, which we shall in due course have to do, those dividends will be so increased that I honestly believe you will have a chance of getting returns of cent. per cent. upon your investment in the capital of the company. You will be glad to hear that our difficulty is not to take orders, but to know what orders to refuse out of the great number on offer. As you know, there is a French Elmore Company formed to work the process in France, and last week I had the honour of being invited to see their works. These works are now in operation, and though designed for an output of 90 tons a week already, their manager reports that he can sell double their proposed output. From these remarks, and the figures which Mr. Elmore will give you, you will see there is not the slightest question about our getting a sufficiency of orders. I have no dividend to declare, but I can state to you, gentlemen, that we are to-day actually earning a considerable one—there is £500 profit in our tanks for this week—and I myself expect that before very long we shall be able to send each of you a nice little cheque as the result of what we are earning. I should like to say a few words about our investment in land referred to in the report. As you are aware, we are not a land company, and in the ordinary course we should only have bought sufficient land for our own immediate requirements, but being myself an adjacent landowner, and knowing well its value in the neighbourhood of the rising town of Leeds, and finding that we should have to pay some-

thing like £2,000 an acre for any extension of our works, and then be exposed later on, if we wished to further increase them, to still larger demands, I strongly urged the board to make the purchase of the whole estate at Haigh Park. This the company did not see its way to do at the time, and Mr. William Elmore very pluckily stepped in and bought the property. Later on, when the land had increased in value, and we saw the bargain that Mr. Elmore had, we readily accepted his generous offer to let the company take over the purchase at the original price. Since that time, as we have mentioned, the value of the land has greatly increased, and I will read you a letter from a gentleman who is acknowledged in Leeds to be the greatest authority on the value of land in that neighbourhood. He writes as follows:—

"Aire and Calder Navigation, Leeds,
"*December 26th*, 1891.

"My dear Atkinson,—You ask me my views in regard to the Haigh Park Estate, lately belonging to Lord Stourton, and now acquired by a company with which I believe you are connected.

"It is a valuable property, and in the near future must become exceedingly so, as any considerable extension in the manufacturing industries of Leeds must necessarily be in that direction, for there is no land so suitable or now available.

"I do not know whether you are aware of the fact that the proposed South Leeds Junction Railway of the coming session passes through the estate on its western side. This, if passed by Parliament, will enhance the value of the estate, although it is already exceptionally situate by having the Aire and Calder Navigation, with its easy connection on one side, and a junction with the Midland Railway on the south side.

"Altogether, I think the company have done well to acquire the estate, and especially if they can afford to wait awhile before realising.

"Yours sincerely,
"W. H. BARTHOLOMEW."

In addition to this and the other advantages set out in the report, the Midland Railway Company have not only agreed to spend a considerable sum in improving the means of communication with the estate, but have also arranged, later on, to build a passenger station contiguous to our property. In justice to Mr. Elmore, I must say that he has worked like a Trojan, and even if he has been slow in getting our company to its present prosperous position, he has, nevertheless, given one of the greatest possible proofs of his zeal for the company, and his interest therein, by giving up his purchase precisely on the same terms as he had procured it. If he had been a stranger, there would have been nothing wrong in his asking £25,000 profit on the price, and then we should have had a bargain. In fact, if at the end of a year or two the company do not find that they have made a splendid bargian, I shall be very glad to take it off their hands. I think, therefore, that our thanks are very much due to Mr. Elmore for the excellent position he has put us into in that respect, and I have no doubt that, before we part, you will favour him with a vote of thanks instead of a cheque for the profit he might otherwise have made. Three members of the board retire. Sir John Morris is not allowed by his physician to offer himself for re-election, but possibly he may be able to join us again later on. With regard to the other two members, Mr. Carson and myself, I may say that Mr. Carson, from his knowledge as a director of the Cape Copper Company, of which he was originally the manager, has been of great assistance, and is one of the four largest holders of our shares. I, myself, have every confidence in the great value of this invention, and have had ever since it was only an idea in the mind of the inventor. I hold over 8,000 shares in the company, and have upwards of £40,000 in the various Elmore companies, and have never sold a single share, even when they were at £8 each, which figure I believe they will soon be at again. On the contrary, I have been steadily increasing my holding. In fact, I may say the directors of your company are by far the largest holders in the company, holding, I believe, nearly a third of the issued capital. Gentlemen, I now beg to move, "That the report and statement of accounts for the year ending June 30th last be passed and adopted."

The following report of Mr. Elmore, the managing director, was then read by the Chairman:—

"I beg to confirm my report of November 30th last, and the gratifying results I was then able to foreshadow, and to state that our experience since more than bears out my figures.

"Since my previous report of June 1st, 1891, the new copper mandrel has proved to be all that I then claimed for it, and it even exceeds my expectations, simplifying the process immensely.

"I send you the two tubes recently tested by an independent expert, one made by our electro-burnishing process and the other one a brazed tube of the best ordinary make. The result of the trial you already know of, viz., that the Elmore tube turned out to be not only more than three times as strong as the best brazed tube, but of such high uniform quality that, although the testing machine had to be specially made, the machinery actually gave way two or three times in the course of the tests, and had to be strengthened to meet the great resisting power of the Elmore tube. From this it will be seen that the company will practically have a monopoly of steam pipes of large diameter, and that marine engineers will at once abandon the use of brazed copper pipes, which have given them so much trouble of late by bursting under the high steam pressures used in the triple and quadruple expansion engines, some fifty or sixty lives having been lost during the present year from this cause; and I may state that we have already received some important communications and assurances to this end. The difference in the two kinds of tubes cannot be better expressed than in the words of the eminent engineer who made the test, as follows:—

"'I beg to inform you that I have to-day witnessed the bursting of two experimental copper pipes, one made by your electro-burnishing process, the other, an ordinary brazed tube, made by a first-class coppersmith in Leeds.

"'The first pipe is 5 feet 6 inches long, 9½ inches in diameter inside, and ½-inch thick. The pressure was applied to the inside of this pipe by means of a three-throw hydraulic pump driven from the shaft in the shop; up to a pressure of 1,000 lbs. per square inch the pipe showed no signs of distress. At a pressure of 1,176 lbs. to the square inch the pipe commenced to expand in the middle uniformly, until this part of it became ⅝-inch larger in diameter than the other part, and water commenced to pass from four separate points almost opposite to each other, showing that the metal was stretching uniformly, and that the pipe was almost on the point of bursting. The pressure was again increased until 1,456 lbs. to the square inch was reached, when the pipe stretched at this part from 9½ inches outside diameter to 11 inches, and at this pressure it burst, opening out in the centre of the pipe for a distance of about 10 inches, the fracture being 1¼ inches wide.

"'The pipe was afterwards measured, and it was found that although at the moment of fracture its diameter was 11 inches and the metal had stretched uniformly to that extent, still when the pressure was released the pipe returned to a diameter of 10⅝ inches.

"'The next pipe, that is the brazed one, was 9 inches diameter, also 5 feet 6 inches in length, and ½ inch thick. At a pressure of 120 lbs. to the square inch, one end of the pipe swelled to the extent of ⅛ inch in diameter for a distance of about 12 inches from the flange, and as the pressure was increased to 300 lbs., the opposite ends swelled in like manner, which clearly proves that in heating the copper to flange it at each end its ultimate strength had been greatly reduced. The pressure was again increased to 448 lbs. to the square inch, when the pipe burst at one end about 12 inches from the flange through the brazed joints, thus demonstrating that the electro-burnished pipe, although ¼ inch larger in diameter than the brazed pipe, was 3½ times stronger, and further demonstrates that owing to the great ductile properties possessed by the electro-burnished copper which admits of its being flanged without being heated, enables pipes of this description to be constructed of a uniform strength throughout.'

"It is important to notice that the Elmore tube was flanged (in the ordinary way by an ordinary workman) without annealing, thus preserving to the metal its whole original strength, and avoiding all possible chance of deterioration of the metal by overheating, owing to want of skill or carelessness on the part of the workmen. As showing the rapidity of the growth of our trade, and the favour in which our goods are held by those who have tried them, I would state that we have already, during the last two months, added no less than 130 customers to our list, comprising some of the best firms in the country.

"We have executed 342 orders, and have to-day more orders offered than we can possibly execute.

"Further, one large buyer has given 16 repeat orders; one has repeated orders 14 times; two have repeated orders 12 times each; three have repeated orders 11 times each; two have repeated orders nine times each; five have repeated orders seven times each; three have repeated orders five times each; seven have repeated orders four times each; ten have repeated orders three times each, and an aggregate of 224 repeat orders have been received from a number of our customers, representing about 40 per cent. of the total names upon our books.

"We have on hand orders and offers of orders at prices above those that I estimated in my last report, which will far more than fill our capacity for a long time to come. In addition, since the 20-ton plant was started, we have received specifications and sent out quotations in reply to inquiries for 1,581,669 lbs., or over 700 tons of copper tubes for various purposes, besides a large amount of copper to be deposited upon rams and and other expensive articles, from which to draw our orders and keep our tanks constantly employed.

"The following extracts from letters received during the past few days will be of considerable interest:—

"'Our opinion is that between copper printing rollers and steam pipes alone our district should be capable of absorbing from 50 to 60 tons per week.'

"'All the other conditions such as prices, terms, &c., being equal, we do not see why you should not secure the bulk of the business to be done in our district; but, as you wish to have a safe figure for a definite calculation, we should certainly undertake to dispose of not less than 20 tons of goods referred to, in our district.

"'The results of the bursting tests go to still further prove the excellence of your copper and the bursting pressure—viz., 1,456 lb. per square inch for your pipe, against 448 lb. for brazed pipe, are so wide and absolutely convincing, as to leave no question as to comparative quality.'

"'Since I had the pleasure of seeing you in Leeds, I have made inquiries from the various shipbuilding and engineering ports in the kingdom, as to the weight of copper steam and feed pipes used per year in marine engineering, and I find that the consumption is from 3,600 to 4,000 tons per annum (this includes pipes used for Government vessels as well as vessels built for the mercantile marine), and they range in size from 2 inches in diameter to 12 inches.'

"'Do you propose making copper rollers for calico printing purposes. There is a demand of from 35 to 50 tons per week for these'."

"The above statements are with regard to what we have accomplished in the ordinary manufactures.

"I further have pleasure to officially inform you that another stage in the realisation of the promises that I have made has been reached, which, with the exception of the delay in actual completion, have been more than borne out in every case. This important step is the satisfactory production of a copper cartridge-case, the value of which may be gathered from the fact that it means the successful appli-

cation of the Elmore process to pans for brewers and distillers, and other articles not of tubular form, but having a bottom. From the samples I send it will be seen that not only is the copper cylinder closed at one end, but the thickness of the copper can be regulated at will, to be thick at one part and thin at another, as desired, whilst the quality is kept at the same high standard as our tubes.

"If it is possible, as has been proved, to produce such an article by the Elmore process, it can at once be seen by any expert that it is far easier to produce an ordinary pan, and in my estimate of profits, which I made out on November 30th last, no allowance whatsoever was made for such special articles, the extra profit upon which will all be in addition to what was there set out, and the fact that I am at present negotiating for making arrangements for the granting of a license for the manufacture of a minimum of 10 tons of these cases per week, on a royalty that will be most remunerative to this company, will show that I have erred on the safe side in making out my estimate of profit. In this report of to-day I have confined myself to what has actually been done and proved, and I consider it unnecessary to refer to the fact that our process is equally applicable to the deposition of other metals, and the manufacture of heavy ordnance, of a quality hitherto unknown, and I think you will find, as in the past, that every statement ever made by me as to the various applications of the process will be as fully borne out as those regarding the turn-out of copper tubes and such like articles; this I have been able to prove to you to-day."

At the conclusion of the reading of Mr. Elmore's report, the CHAIRMAN moved the adoption of the report and accounts.

General FIFE seconded the motion, which was carried unanimously.

Questions were then invited.

Mr. PILCHER said that his firm ordered from the Elmore Company copper pipes, but after they had been used a short time they became laminated throughout, and proved to be an utter failure in every way, and they went back to the old style.

A SHAREHOLDER said it was stated in Mr. Elmore's report of June 30th that one half of the regular customers had repeated orders; further on the report stated that "next week our works will be in the position to double the output." When one, however, turned to the accounts, there did not appear to be anything in the way of manufacturing going on.

Mr. PILCHER asked how the price of Elmore copper compared with the ordinary?

A SHAREHOLDER wanted to know how many tons of piping had been produced from June 30th last to November 30th?

Another SHAREHOLDER asked whether the directors had received their fees this year.

Mr. WM. ELMORE, the managing director, said the shareholders would notice that the accounts were made up to June 30th. At that time they were turning out very little copper from the tanks, consequently there was very little profit shown in the statement of accounts. At the present time they were turning out a large quantity of copper tube. With regard to the laminated tubes, he was glad of the opportunity of answering the question. When they commenced operations they started with a very defective engine, which was made by one of the best engineering firms in the world—or supposed to be.. This engine gave considerable trouble, and was always breaking down. A second engine was supplied by the same firm, which had to be taken away. That was the cause of the laminated tubes. Before he took charge of the works at Leeds some of these tubes (to the number of six) were sent out, causing great concern to the company. They were afterwards collected.

Mr. PILCHER did not see how the engine caused this.

Mr. ELMORE: By stoppage. If the engine stopped the operation in the tanks ceased, and the stoppage of the mandril caused a film of oxide to form on the surface, and copper placed on this would separate from the underlying metal. The process was essentially a continuous one. A stoppage of two or three minutes, or even an hour, would not hurt, but a stoppage of long duration—say, a day or so—which very often happened in the early days, dust would settle, and would eventually cause lamination. That, however, was a thing of the past. They had sent copper out during the last six weeks to the best firms in the world, who had not only expressed high satisfaction with the quality, but had repeated their orders ten, twelve, fourteen, and sixteen times. He had received a letter from a large user in Manchester, who had promised an order for 1,000 tubes 22 inches in diameter, more than three or four hundred tons. If Mr. Pilcher would allow them to supply other tubes, they would be glad to do so.

Mr. PILCHER said they were afraid to give another order.

Mr. ELMORE, continuing, said it was for that reason they desired that official tests should be made by experts of the Board of Trade, the Admiralty, and Lloyds. His request had been acceded to, and they had received from the Board of Trade engineers' specifications of the plant necessary for the tests. They had carried out tests, and the results had been greatly in favour of the Elmore tube.

Mr. PILCHER asked if his firm were to give an order for Elmore tubes, would the company undertake to put in pipes of the old type, should the Elmore copper fail?

Mr. ELMORE said he would do so.

Mr. PILCHER said in that case he would undertake to give an order. (Applause.)

Mr. F. RAWSON said he would send a cheque to Mr. Pilcher for £500 if the tube proved in any way defective. (Applause.)

Messrs. Atkinson and Carson were re-elected directors, and Messrs. Price, Waterhouse and Co. were reappointed auditors.

Dr. CANTRELL next moved a vote of thanks to Mr. Elmore and the company's staff.

Mr. GUARRICINO seconded the resolution, which was agreed to.

The meeting closed with a vote of thanks to the chairman and directors.

The Edinburgh Electric Supply Corporation, Limited.

THE Edinburgh Electric Supply Corporation, Limited, held their second annual meeting at 17, St. Andrew's Square, Edinburgh, on Wednesday of last week, Mr. WALTER BERRY, Edinburgh, presiding.

The report of the directors showed that at the end of July, 1890, 127 citizens in Edinburgh and Leith gave their names as supporters of the corporation scheme. In terms of a printed circular in June last, the directors issued a prospectus and pamphlet embodying detailed information regarding the aims of the corporation; and a second circular requesting the then supporters of the scheme to make application for shares met a most favourable support; and there were now 206 shareholders enrolled, many of them very prominent citizens. Shares to the number of 16,000, at £5 each, had been already privately issued. The privately-subscribed capital was £31,175; paid-up capital, £1,558 15s. The corporation felt they were now in a very strong position. On September 10th last the directors approached the Lord Provost's committee by letter, with the view of coming to some arrangement for the lighting of the compulsory area proposed in the provisional order. This letter was submitted by the Lord Provost's Committee to the Electric Lighting Committee for consideration. The municipal elections and the tramway question had hitherto absorbed the attention of the Town Council; but the question of the electric lighting of the city would have to be shortly considered by the council, as they had now obtained the Royal assent to their provisional order, and had only about three years in which to complete the work specified.

The CHAIRMAN, in moving the adoption of the report, said he had to express the regret the directors felt in still being unable to intimate any progress towards the definite fulfilment of the object for which the company was formed; but no one was to blame for that. Without being too pressing, the directors had not failed to urge their claims on the Town Council, and he could not doubt that these would be favourably considered, when the council was in a position to come to a decision. They must, of course, recognise that their representatives in the council might decide that in the public interest it would be preferable for them to undertake the work themselves, and he had no doubt, should they so decide, their decision would be arrived at on sufficient grounds. In that case the existence of their corporation would terminate, and the preliminary subscriptions of the shareholders would be returned in full. As they were aware, the reasons why this company was originally formed were, first, that it was deemed that there was sufficient business capacity in Edinburgh to carry out the electric lighting of our city, and that there was sufficient public spirit to form a local company for that object; secondly, that they objected very strongly to be tied to any one system. They knew that the company against which they appeared as competitors was limited to its own special method, against which he had not one word to say. It might still prove the best, but they thought it well worth the trouble involved to attempt to keep the city free to adopt the best obtainable. Therefore if the city entrusted the electric lighting of Edinburgh to their company, they should do their best to keep in the front rank, both scientifically and practically. Great strides had been made within the last year in electric lighting. The recent Frankfort Exhibition had brought many useful adaptations and inventions before the public, and although it would be foolish not to recognise that many more would be discovered, they could not wait indefinitely for that. They had at any rate the advantage of studying many failures and mistakes, and would profit by them. He felt confident that if the company was entrusted with the work it would be done as well as the present position of the science would admit. They were naturally anxious to have the business, but the shareholders might rest assured that although their directors would not be greedy for profit, they would not undertake any contract which did not, in their view, leave a good margin for interest and risk.

Mr. GEORGE BARCLAY said he had great pleasure in seconding the adoption of the report, because he thought both the report and the chairman's remarks indicated that the directors had been proceeding on wise and prudent lines, and, that being so, there was good reason to believe that should the corporation eventually succeed in getting the concession from the city on fair and reasonable terms, the same directors would carry out the enterprise to a successful termination.

The report was adopted.

The Eastern and South African Telegraph Company, Limited.—This company notifies the restoration of its Aden-Zanzibar cable, thus re-establishing telegraphic communication with South Africa by the East Coast. Both the East and West Coast routes are now in working order.

Elmore's Wire Manufacturing Company, Limited.

THE directors' first annual report and statement of accounts for the period from March 15th, 1890, to October 31st, 1891, states that the directors have the pleasure to submit their report and the accompanying statement of the company's audited accounts for the period com-

mencing with the incorporation of the company on March 15th, 1890, and ending on October 31st, 1891.

The period in question has been devoted entirely to the erection of the company's works upon 13 acres of freehold land purchased from the parent company, and immediately adjoining that company's works. The main building consists of a series of bays, each 400 feet long by 35 feet wide, having a total width of 350 feet, under one roof, and covering a space of about 3½ acres. These buildings have been designed with a view to an output of 140 tons per week.

There are also offices for the staff and managing director complete in every respect, together with convenient store and packing shed, with sidings from the Midland and Great Northern railways, already connected up therewith.

The actual progress made at the works, as reported by the managing director, is as follows:—

Buildings, comprising shop, engine house, depositing sheds, boiler house, dynamo and engine house, and machine shop, for an output of 140 tons per week.

Chimney shaft, 240 feet high, for 280 tons.

Railway sidings.

Overhead cranes throughout, and melting furnaces and flues for 140 tons.

Boilers, generating engines, dynamos, and electrical switches for 44 tons.

Fuel economisers, tanks, and tank gearing for 35 tons.

Engine and dynamo for the electric lighting of the whole works inside and out.

Shop engine, shafting, and additional gearing, slitting, flattening, straitening, and other machinery for 70 tons a week.

From this enumeration it will be seen that the works will make a start with an output of about 35 tons a week. This can be readily increased up to 70 tons a week with little additional expenditure above that already incurred.

The company has also acquired from the parent company, upon a moderate royalty, the sole license outside the requirements of the parent company for the manufacture of copper sheet, under a patent taken out by the parent company last year; and the board consider, in view of the large demand for copper sheet, that this license will prove of great value.

Since the company was formed, and the buildings commenced, the directors have learned with satisfaction that the whole of the proposed output can be readily disposed of in the form of ribbon or tape and planished sheet, at a profit considerably in excess of that estimated from the sale of wire spirals. The company will therefore neither erect wire drawing plant on a large scale for the present, nor dispose of its copper spirals to wire drawers, thus adding to the gross earnings of the company one manufacturing profit.

Mr. Elmore, managing director, reports that early in the year 1892 the company will be in a position to commence with an output of 35 tons per week.

In regard to the accounts, these are exceeding simple; inasmuch as no trading account having yet been opened, the only outgoings beyond capital expenditure are those occurring under administration expenses, which, however, have been reduced by one-half, largely in consequence of the satisfactory profit derived from a judicious investment last year in consols and Bank of England stock.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., offer themselves for re-election, and the directors recommend a payment of 35 guineas for their services.

By order of the board,
J. SHURMER, *Secretary.*

BALANCE-SHEET, October 31st, 1891.

Dr.			£ s. d.
To Nominal capital			300,020 0 0
„ Share capital issued—			
67,385 Ordinary shares of £2 each	£134,770 0 0		
1,360 Less shares forfeited ...	2,720 0 0		
66,025	132,050 0 0		
Less calls in arrear ...	12,751 5 0		
	119,298 15 0		
Add amount received on forfeited shares ...	390 0 0		
	119,688 15 0		
10 founders' shares of £2 each...	20 0 0		
			119,708 15 0
„ Premium on shares issued—			
£1 per share on 66,025 shares ...	66,025 0 0		
Less in arrear	3,240 0 0		
	62,785 0 0		
Add premiums received in respect of forfeited shares ...	62 10 0		
	62,847 10 0		
Of which one-half credited to vendors in part consideration of purchase price ...			31,423 15 0
„ Reserve fund—one-half of premiums received to date... ...			31,423 15 0
„ Sundry creditors			8,301 19 11
			£190,858 4 11

Cr.			£ s. d.
By Cost of licenses			111,505 0 0
„ Cost of land at Leeds			13,000 0 0
„ Investment account			8,200 0 0
„ Buildings and machinery			41,282 11 3
„ Stock of raw copper			5,314 17 10
„ Furniture, fixtures and fittings			329 14 10
„ Administration expenses			5,268 5 5
Less—			
Interest and Discount received...£1,725 3 5			
Profit on investments 891 18 7			
Transfer fees ... 76 18 6			
	2,694 0 6		
			2,574 4 11
„ Sundry debtors			485 6 5
„ Cash at Bankers and in hand			8,166 9 8
			£190,858 4 11

Audited and found correct.

DELOITTE, DEVER, GRIFFITHS & Co.
Chartered Accountants, Auditors.

4, Lothbury, London, E.C., *December 18th*, 1891.

The first annual meeting of this company was held at Cannon Street Hotel, on Wednesday last, Mr. J. J. Atkinson in the chair.

The SECRETARY (Mr. J. Shurmer), having read the notice convening the meeting,

The CHAIRMAN said: The report speaks for itself, and is so exceedingly simple, that in addressing you I can have very little to say. What will strike you first is that a company calling itself a wire manufacturing company, should propose to you, its shareholders, after you have subscribed your capital, not even to put down plant to draw wire at all. This admits of an easy explanation. Gentlemen connected with the wire-drawing trade, and having large capital invested in drawing plant, approached us some time previous to your last general meeting, and having thoroughly tested the quality of the copper to be produced by us, offered to take our entire output at a price which, while satisfying us, did not interfere with their own business of drawing. Your directors considered that this arrangement was better than entering into competition with the whole trade. This was explained to you at the last general meeting. Since then we have ascertained the fact that by depositing our large copper tubes up to about a quarter of an inch, and over, and then cutting them up into a wide spiral of, say, two inches, which can be done very easily indeed, we have a form of copper-ribbon or tape used for electric lighting and transmission of power. While the demand for this copper-tape exceeds our entire output the price is much in excess of the best price we could obtain for wire spirals such as the wire-drawers would have taken, so that even before the whole of our works are complete we shall have a better market for our produce than was contemplated when the prospectus was issued. The electric lighting of a town like Leeds would keep us busy for a length of time, and I am informed that for the electric lighting of London alone over 100,000 tons of this kind of strip will be used. A second very simple invention is likely to form an important source of revenue to us. It was found that by exposing the mandrel to the oxydising action of the atmosphere for a few minutes, when a certain thickness of copper was deposited upon it, and then continuing the operation till a similar thickness of copper was deposited, and by a continual repetition of this process a series of tubes could be formed entirely separate and distinct from one another. One cut down the length of these superimposed tubes gave, when opened out, a number of beautifully burnished sheets of perfectly even surface and thickness, and equal in every way to those known in the trade as planished sheet. These, of the size furnished by us, cannot be procured at the present time in the market, and consequently they will command a high price. All I have to say in addition is, that this meeting was put off to the last minute in the hope that I should be able to announce to you that the 35-ton plant was at work; the fog and the Christmas holidays has prevented it, but there is steam in our boilers, and very little more to do at the plant, and we hope within three weeks or so to be at work. Our business being a mere repetition of the same process over and over again, and the fact that we have no customers to seek, or market to create, make it evident that as soon as ever we get a start our dividend-earning will commence. Some of you have seen the works, and know from what you have seen that a great deal has been done, and the drawing (which was shown to the shareholders) will give those who have not been down an idea of the size of our premises, which, I am told, comprise the largest shed in Yorkshire.

MR. W. ELMORE, in the course of his remarks, said that they had been very much delayed in the commencement of the work by the inability of the contractors to finish the manufacturing plant, they were something like five months behind with the contracts, but everything was now complete and they would have an output of 35 tons as soon as the plant was in operation. When this was done they would increase the plant until they were able to produce 140 tons output, a demand for which at present existed.

After replying to a question as to the sufficiency of the motive power, the CHAIRMAN proposed the adoption of the report and accounts.

Mr. CARSON seconded, and it was carried unanimously. The auditors were re-elected.

A vote of thanks to the Chairman and Mr. Elmore were then passed, and the meeting terminated.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Dec. 23rd.)	Closing Quotation. (Dec. 31st.)	Business done during week ending (Dec. 31st, 1891.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	50 — 51	50½— 51½	51	50½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	88 — 89	88 — 89	88¾	87¾
2,849,510*l*	Do. do. Deferred	Stock	13½— 13⅝	14 — 14½	15⅛	14
130,000*l*	Brazilian Submarine Telegraph, Limited	10	11 — 11½	10¾— 11½xd	11⅜	...
53,200*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	101 —105 xd	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3½— 3⅝	3½— 3⅝	...	...
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2⅛	2⅛— 2⅜	2⅜	2⅛
40,000*l*	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3½— 4½	...	...
50,000*l*	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152*l*	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	6	5½— 6	5½— 6	5⅞	...
$7,716,000	Commercial Cable, Capital Stock	$100	145 —148	149 —151 xd	...	...
224,850*l*	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅜— ½	⅜— ½	...	...
100,000*l*	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	5	5½— 6	5½— 5⅝xd	...	...
16,000*l*	Cuba Telegraph, Limited	10	10 — 11	10 — 11	10¼	...
6,000*l*	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931*l*	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 3⅝	3½— 3⅝	...	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9½— 10½	11	10⅞
60,710	Direct United States Cable, Limited, 1877	20	10⅞— 11⅛	10⅞— 11⅛	11	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14½	13⅞— 14⅛	14½	14
70,000	Do. 6 p. c. Preference	10	14⅜— 15½	14⅜— 15½	15⅛	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	108 —111	109	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	108¼	107
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15½	15 — 15½	15 3/16	...
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	107 —110	107 —110	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	100¾	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6½— 7	6 — 6½xd	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ..	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅞— 2	2⅛— 2⅜	2 1/16	2
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅛— 2⅜	3⅜— 3⅝	3 11/16	3
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅞— 2	2⅛— 2⅛	2⅛	1⅞
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜— 10	9⅞— 10⅛	10 1/16	9 15/16
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15	14⅞— 15	15	...
150,000	Great Northern Tel. Company of Copenhagen	10	19 — 19½	19¼— 19⅝	19⅛	19
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 466*l* to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20½— 21½	20½— 21½	21	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42⅝	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	4 — 5	4 — 5	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8¾— 9¼	8¾— 9¼	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9½— 10	9½— 10	...	...
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝xd	4⅜— 4⅝	4 9/16	4½
15,000	Do. 6 p. c. Cum., 1st Preference	10	12¼— 12½xd	12¼— 12⅜	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12½xd	12 — 12½	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109	105 —108 xd	108½	105
250,000*l*	Do. (issued at 5 p.m., all paid)	25	29 — 32	29 — 32	...	...
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	6 — 7	6½— 7½	...	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16— 5/16	1/16— 5/16	...	...
9,000*l*	Reuter's Limited	8	7¾— 8¼	7¾— 8¼	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8½— 9	8½— 9	...	...
7,900	Do. do. do. 7 per cent. pref.	5	7½— 7⅞	7½— 7⅞	...	...
3,381	Submarine Cables Trust	Cert.	117 —122	117 —122	...	...
78,949	Swan United Electric Light, Limited ... ... (£3¼ only paid)	5	4¼— 4⅜	4¼— 4⅜	4 7/16	...
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43	...
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	80 — 90 xd	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8 xd	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	97 —100	97 —100	...	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	4¼	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	100 —105	97 — 101xd	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10¼— 10⅜	10¼— 10⅜	...	...
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6⅜	6¼— 6⅜	...	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	4 — 4½	4 — 4½	4 1/16	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1⅞	1⅝— 1⅞	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9 — 9½	9 — 9½	9 1/16	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	7½— 8½	7½— 8½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼— 6⅝	6¼— 6⅜	6½	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅝.—Electric and General Investment, Shares of £5, £1 paid, 2⅜—3¼.—European Sims-Edison Torpedo Company, shares of £20, fully paid, 20—20½.—Halifax and Bermuda Cable, 4½ per cent. bonds, 85—95.—House to House Company (£5 paid) 4½—5.—†Liverpool Electric Supply, Shares of £5, £3 paid, 2⅜—2⅝. Shares of £5 (fully paid), 4⅞—5⅛.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅛—1⅜. Do. 6 per cent. Preference, 1⅝—2¼.—Manchester, Edison and Swan Company, £9 (£1 paid), ½—⅝.—National Telephone Debentures, 2½—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2½—2⅝.—½£5 Preference, fully paid 3⅝—3¾.—Wards Electric Car, £10 paid, ⅜—1.

† Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—3½ per cent. (December 10th, 1891).

DEDUCTIONS FROM MR. SPEYERS'S RESEARCHES ON THE ELECTROMOTIVE FORCE OF METALLIC SALTS.

WE now turn to the conclusions deduced by Mr. Speyers from his researches on the electromotive force of metallic salts. The foregoing results, taken collectively, clearly indicate the probability that the electromotive force is increased by dilution, even if it does not prove it. And now for the explanation. Is an explanation of this supposed law, to be found in the dissociation or, better, *ionisation* hypothesis ?—an hypothesis which asserts that a metallic salt in solution is partially separated into its ions, and that dilution increases the quantity thus separated or ionised, so that in a dilute solution no ions exist in combination.

As yet no satisfactory explanation has been deduced. Ionisation increasing with dilution, the mean free path of each ion is lengthened ; wherefore each atom, positive as well as negative, is less under the influence of the other, and appears, therefore, to impart more electricity to its electrode —to raise it to a higher potential. But this is hardly more than a statement of the above results in other words.

On the other hand, according to Sohnke (*Zeitschrift für physikalische Chemie* iii., 1), the ionisation hypothesis readily explains the production of electricity. On introducing a metal into an electrolyte—an acid, for instance—both ions, in this case hydrogen and the acid radicle, will strike the metal. The negative ion will attract positive electricity, repelling negative, and go off with the metal in chemical combination, while the positive hydrogen ion will attract negative electricity, repelling positive, and thereby becoming neutral.

But this does not continue indefinitely, nor until the metal is dissolved, for two reasons : first, the accumulated negative electricity gradually repels the negative ion, and finally altogether forbids its contact with the metal ; secondly, the more negative the metal becomes, the more hydrogen it attracts, which, accumulating on the surface, effectually shuts out the negative ion. The first is auxiliary rather than essential ; for it is probable that before negative electricity could accumulate sufficiently altogether to repel the negative ions, it would be carried off by the liquid ; for a piece of gold leaf thrown into an aqueous solution of chlorine readily dissolves. The second, however, is very effective in bringing matters to a standstill.

On introducing a second metal into the acid a similar process occurs, but not to the same extent ; for there is cumulative evidence that elements differ in their relations to electricity, each allowing it to pass, but with diverse facility. So soon as electrical connection is established, the potential of the two electrodes is equalised, and therefore diminished on one electrode and increased on the other. The result is that the negative ion which was in equilibrium with the electrode of lower negative potential is repelled, as the negative potential is increased, toward the electrode at first of higher negative potential, when also the equilibrium, being disturbed by a reduction of negative potential, negative ions can again approach. At the same time the attraction for hydrogen is diminished, but is increased at the other electrode by the higher negative potential, and consequently hydrogen collects here. So long as electrical communication is kept up this state of things is continuously renewed, and a current produced and maintained by the partial discharge of the hydrogen ions, and carrying off of electricity by the negative ions with the metal.

Assuming that the positive and negative ions act very differently upon electricity, and by pushing this assumption, we may reach a somewhat reasonable emplanation of chemical affinity based upon the non-conductivity of the non-metals, and the well-known mutual attraction of positive and negative electricities. In doing so it must be premised, says Mr. Speyers, that the total quantity of electricity contained *within* * any given mass of an element is constant (possibly it may vary as the equivalence, but for the present this is to be left undecided) ; that in metals and other good conductors this electricity may be all positive electricity, or positive and negative. When these are present in equal quantities the atom is neutral.

* This excludes any artificial charge to be found on the surface.

The non-metals are non-conductors and contain negative electricity. Their atoms are like spheres surrounded by an insulating shell within which is one or more charges of negative electricity. When such an atom comes in contact with a metal the positive electricity is attracted, the negative repelled ; but as the electricities cannot unite, owing to the insulation of the negative ion, a quantity of matter containing the same number of unit charges of *positive* electricity is carried off with it in so-called "chemical combination." Therefore the better the insulation of the negative ion and the less negative electricity in the positive ion, the more firmly are the ions chemically united.

In accordance herewith combinations of metals should be weak ; likewise those of non-metals, owing to the presence of negative electricity. But a combination of a non-conductor or insulator with an excellent conductor should be strong ; and this idea experience confirms.

The separation of this electricity consumes energy, and, as indicated in a previous paper by Mr. Speyers, we might expect to find the chemical energy, as measured by heat, equal to that consumed in the separation.

In order that this equality may exist, the performance of other internal work is impossible ; but as internal work generally exists, the equality is exceptional. Helmholtz has, indeed, demonstrated the matter, though not in this form. By thermo-dynamical manipulation, he has shown (*vide Gesammelte Abhandlungen*, ii., p. 961), that whenever the electromotive force is a function of temperature, the two energies in question are not equal, but that the relation between heat (Q), internal energy (U), temperature (T), electromotive force (p), and quantity of electricity (e), is :

$$d\,\mathrm{Q} = \frac{\delta\,\mathrm{U}}{\delta\,\mathrm{T}}\,d\,\mathrm{T} + \frac{\delta\,p}{\delta\,\mathrm{T}}\,d\,e.$$

Yet, since this demonstration requires the aid of the second law of thermo-dynamics :

$$\int \frac{d\,\mathrm{Q}}{\mathrm{T}} = 0,$$

the first equation is only strictly appplicable to reversible cells ; however, the principle involved therein, that the internal energy must be considered, is of universal application. Hence the futility in expecting to find the chemical and electrical energies numerically equal, and this is well shown by a comparison, so far as thermal data will permit, of the calculated and observed electromotive forces of zinc, copper, iron, tin, and mercury in solutions of hydrochloric and nitric acids.

If the electrodes are electrically disconnected, we have :

$$\mathrm{M}\left\{\begin{matrix}\mathrm{H}\\ \mathrm{Cl}\end{matrix}\right. + \mathrm{HCl\ Aq} + \left.\begin{matrix}\mathrm{H}\\ \mathrm{Cl}\end{matrix}\right\}\mathrm{Hg},$$

$$\mathrm{M}\left\{\begin{matrix}\mathrm{H}\\ \mathrm{NO_3}\end{matrix}\right. + \mathrm{HNO_3\ Aq} + \left.\begin{matrix}\mathrm{H}\\ \mathrm{NO_3}\end{matrix}\right\}\mathrm{Hg},$$

Accordingly, each electrode tending to produce a current in opposite directions, the difference of the chemical energies is to be taken as the measure of electromotive force. We have from Thomsen's data (*vide Thermochemische Untersuchungen*) :

$\frac{1}{2}\,\mathrm{Hg} + \mathrm{HCl\ Aq} = \frac{1}{2}\,\mathrm{Hg\,Cl_2\ Aq} + \frac{1}{2}\,\mathrm{H_2}$	− 14,350	calories.
$\frac{1}{2}\,\mathrm{Zn} + \mathrm{HCl\ Aq} = \frac{1}{2}\,\mathrm{Zn\,Cl_2\ Aq} + \frac{1}{2}\,\mathrm{H_2}$	+ 17,120	„
$\frac{1}{2}\,\mathrm{Cu} + \mathrm{HCl\ Aq} = \frac{1}{2}\,\mathrm{Cu\,Cl_2\ Aq} + \frac{1}{2}\,\mathrm{H_2}$	− 7,945	„
$\frac{1}{3}\,\mathrm{Fe} + \mathrm{HCl\ Aq} = \frac{1}{3}\,\mathrm{Fe\,Cl_3\ Aq} + \frac{1}{2}\,\mathrm{H_2}$	+ 3,270	„
$\frac{1}{2}\,\mathrm{Fe} + \mathrm{HCl\ Aq} = \frac{1}{2}\,\mathrm{Fe\,Cl_2\ Aq} + \frac{1}{2}\,\mathrm{H_2}$	+ 10,675	„
$\frac{1}{4}\,\mathrm{Sn} + \mathrm{HCl\ Aq} = \frac{1}{4}\,\mathrm{Sn\,Cl_4\ Aq} + \frac{1}{2}\,\mathrm{H_2}$	− 7	„
$\frac{1}{2}\,\mathrm{Sn} + \mathrm{HCl\ Aq} = \frac{1}{2}\,\mathrm{Sn\,Cl_2\ Aq} + \frac{1}{2}\,\mathrm{H_2}$	+ 1,270	„

The energy equivalent of one calorie is $4{,}153 \times 10^4$ G.G.S. units ; hence the energy (W) of the above reactions is

$$\mathrm{W} = \mathrm{cals.}\ 4{,}153 \times 10^4$$

Now, as one unit of electricity, or one coulomb is contained in 0·001118 gramme of silver, one gramme equivalent of this metal, or any other substance, contains

$$0{\cdot}001118 \times 107{\cdot}94 = 96{,}540 \text{ coulombs.}$$

The energy consumed in produciug this quantity of electricity is determined by its electric height, or electromotive force, that is,

$$\mathrm{W} = 96{,}540\ .\ \mathrm{E\,F} = \mathrm{E\,F}\ 9{,}654\ \text{C.G.S. units.}$$

On combination with the above equation,

$$E F = \frac{\text{cals. } 4{,}153 \times 10^4}{9{,}654 \times 10^8} = \text{cals. } 4{,}302 \times 10^{-8}$$

Therefore for zinc the electromotive force should be

$$E F = 0{\cdot}00004302 \times (17{,}120 + 14{,}350)\ \text{cals.} = 1{\cdot}35\ \text{v.}$$

Similarly for copper = 0·27 v
„ „ ferric iron = 0·76 v
„ „ ferrous „ = 1·08 v
„ „ stannic tin = 0·62 v
„ „ stannous „ = 0·67 v

These results are plotted by Mr. Speyers in straight lines, whilst curved lines represent the observed electromotive forces in hydrochloric acid, and in solutions of the corresponding chlorides.

In another set of curves the results are given for the nitrates, when

$\frac{1}{2}$ Hg + HNO_3 Aq = $\frac{1}{2}$ Hg $(NO_3)_2$ Aq + $\frac{1}{2}$ H_2 − 15,665 calories.
$\frac{1}{2}$ Zn + HNO_3 Aq = $\frac{1}{2}$ Zn $(NO_3)_2$ Aq + $\frac{1}{2}$ H_2 + 17,055 „
$\frac{1}{2}$ Cu + HNO_3 Aq = $\frac{1}{2}$ Cu $(NO_3)_2$ Aq + $\frac{1}{2}$ H_2 − 7,995 „
$\frac{1}{3}$ Fe + HNO_3 Aq = $\frac{1}{3}$ Fe $(NO_3)_2$ Aq + $\frac{1}{2}$ H_2 + 3,316 „

Accordingly the calculated electromotive force should be

For zinc = 1·41 v
„ copper = 0·33 v
„ iron = 0·82 v

An examination of the curves shown on p. 484 of the American *Chemical Journal* shows that, although there is a general analogy between electromotive force and chemical energy, the two are by no means equal.

Particularly interesting is the difference in electromotive force between the *ous* and *ic* compounds. The heats of formation of *ous* salts are probably greater, for equivalent quantities, than those of *ic* compounds, and, consequently, the calculated electromotive forces also should be higher. Yet the observed values of the *ous* salts are lower. It may be urged that a minute quantity of an *ic* salt is formed, and consequently the value depreciated, as this is in general controlled by the lower electromotive force. But the conditions are all unfavourable to the formation of these compounds and with iron and tin, only *ous* chlorides are obtained by the processes supposed to take place in the cells.

In reply to the obvious question whether an explanation may be found in the dissociation hypothesis and the one above, Mr. Speyers says :—As non-conductors have negative electricity so interwoven in their texture that very little, if any, motion of electricity can take place within the atom, when such an atom approaches and touches a mass of metal the negative ion will attract a quantity of the positive ion containing a unit charge and go off with it as a chemical compound. This, as containing the largest quantity of metal, will be the *ous* compound. Before migrating it will meet with negative ions, and possessing a comparatively large charge of positive electricity, may give up a part, but never without accompanying matter, to the second negative ion, thus forming a compound relatively richer in negative ion or an *ic* compound. The quantity of electricity in the positive ion of this being so much less than in the positive ion of an *ous* salt, when a quantity of an *ic* salt is formed equivalent to one atom of the negative ion the heat evolved is necessarily much less than that yielded in the formation of a corresponding quantity of an *ous* salt.

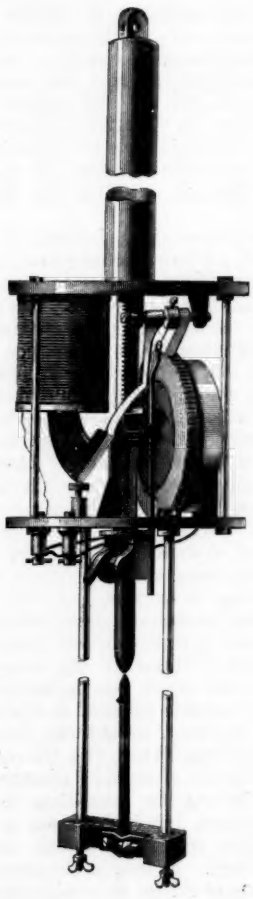
Again, in the preceding explanation of electromotive force, a dynamic equilibrium was supposed—an equilibrium resulting from a charge of the electrode with negative electricity by the negative ion, and a partial removal of that electricity by the positive ion. As the charge of the positive ion is much smaller in the *ic* condition, the electricity removed is also much less, and the potential is therefore higher. Of course, the action is similar on both electrodes, but the electrode least affected in the first case is presumably least affected in the second, and the result is an increased difference of potential or rise of electromotive force.

In this, or some similar direction, it seems that an explanation is to be found; whether it will suffice for all cases future experiments alone can decide.

A change of internal energy in the way of dissociation must not be overlooked, but this can hardly account for such a difference of electromotive force as is observed in solutions of *ous* and *ic* salts. It would, therefore, be of interest to extend determinations to all metallic salts, more especially to metals forming *ic*, *ous* and *per* salts, and to determine if there are any solutions in which dilution lowers the electromotive force while secondary action is excluded.

THE "CROWN" ARC LAMP.

THIS regulator is composed of a solenoid of fine wire coiled round a suitable frame. The armature of the solenoid is capable of traversing a long course, and is carried on an axis to which the toothed quadrant is also fixed. This quadrant is geared into the flywheel, on the axis of which a toothed pinion gears into the toothed rack which carries the upper carbon.



On the first passage of the current, the carbons being separated, the solenoid attracts the armature and the quadrant disengages the flywheel, which, actuated by the weight of the toothed rack, revolves until the carbons are in contact. At the moment of contact, the current passing through the carbons, the armature of the solenoid falls by its own weight, the quadrant gears into the flywheel and carries it round, thus raising the toothed rack forming the arc.

In proportion to the burning of the carbons the arc tends to increase, at the same time the armature is gradually attracted into the solenoid until the last tooth of the quadrant disengages the flywheel, which revolves slightly and allows the carbons to approach again.

Owing to its great moment of inertia, the flywheel has only time to revolve (a distance of one tooth), when the armature, to which is connected the quadrant, falls a short

distance, and by reason of the upper carbon having approached the lower one the fall of the armature is arrested, and again (as the carbons waste) commences rising, thus the feed is constant and quite imperceptible, no flicker being observable when the feed occurs.

By reason of the fine pitch of the teeth of the flywheel the rack which carries the upper carbon falls one-tenth of a millimetre only each time the flywheel is released by the quadrant—thus, a remarkably steady light is secured.

The feed continues according to the burning of the carbons maintaining a normal distance between them.

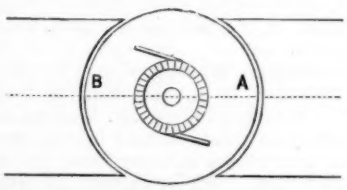
The carbon holders are fitted with a simple eccentric cam for holding the carbons.

The "Crown" arc lamp, which has been on trial at Paddington Station, may be used equally well with either continuous or alternating currents, and, judging from its simplicity and cheapness of construction, it ought to meet with much favour.

A SIMPLE METHOD OF LOCATING ARMATURE DEFECTS.

ALL electricians are aware of the many trials of searching for an armature "short circuit." One method is to run the armature by the usual belting and excite the field; then by observing the heated parts some idea may be obtained where to commence searching for the trouble. It will be understood that the above will only apply to the short-circuiting of a few coils, for when the whole, or nearly the whole, armature is closed on itself by the two adjacent wires touching, running in an excited field will warm all of the wires and, of course, no locating is possible. To add to the trouble, the machine must be belted up and run, which takes time, and repeated trials become very annoying.

Mr. Loomis describes a method in the New York *Electrical Engineer*, devised by himself, which at times has been very convenient. No arrangement for belting need be made; it is only necessary to fasten a monkey-wrench to the rim of the pulley, or, better still, a crank to the end of the shaft. Now excite the fields, and, to make the effects more marked, connect the coils in parallel as the excessive current will only be used for a moment. When this has been done the strongest man will scarcely be able to rotate the armature, and then only with extreme slowness, except at one position. When this position has been found, mark the armature at points in the centre of the pole pieces, A, B, as shown in the accompanying diagram, and at both ends of the armature.



The explanation is that both halves of the armature oppose one another at this position; but when not at these points a continuous circuit is formed and the resultant magnetic effect is enormous. As the "cross" will be found at one of these four marked points it becomes desirable to know in which one it is most likely to be found. Experience has shown that it is nearly always on the commutator end in the last half of the winding where the wires pass down through the first half terminals. In armatures where the windings are equal, he supposes it would be as liable to be at one point as at another.

With this method a defect can be found and remedied in a few moments, for it has always been a simple matter to repair it when discovered. These results can be observed in a perfect armature by connecting the opposite sections of the commutator. When only one coil is short-circuited, the magnetic effect is much less and the points must be marked 90° from the ones shown, but these cases are few and are soon discovered in other ways. The above will be understood to apply to armatures of the drum type with Siemens winding.

BENARDOS SYSTEM OF ELECTRIC WELDING.

WE referred last week to our recent Birmingham visit to witness the improved system of Benardos. Before proceeding to the description of the system, we will make a few remarks upon the general character of the works.

The Coombs Wood Works are situated on the Birmingham Canal in the midst of the thick coal district, and close to some of the best known Staffordshire iron works. They cover part of an estate of some 35 acres belonging to Messrs. Lloyd and Lloyd. They are principally devoted to the production of buttwelded wrought iron gas, steam galvanised and water tubes and fittings, of which Messrs. Lloyd and Lloyd are the largest manufacturers in Europe. Here occupation is given to nearly 1,000 workpeople, many of whom live in the cottages belonging to the firm, which are provided with allotments and a playground for the children. As an illustration of the extent of the demand for their manufactures, it may be mentioned that the average stock at the Coombs Wood Works equals about 200 miles of finished tubes. The works are driven by engines representing in the aggregate 400 to 500 indicated horse-power, and are, to a great extent, lighted by electricity, and special provision is made for ventilation in hot weather by means of three Blackman air propellors. A special feature of the works is the exceedingly careful manner in which every tube and fitting is repeatedly tested and marked by the workman on whose responsibility it is passed as "good," thus ensuring the dispatch of absolutely reliable tubes and fittings. In connection with this, it may be mentioned that a hydraulic system is in use for the whole of the works at a standing pressure of 800 lbs., but by means of intensifying pumps this can be raised to very much higher pressures when required in special cases. Messrs. Lloyd and Lloyd were the first manufacturers of large welded iron tubes by the gas process, and they have developed this branch of the tube trade from very insignificant beginnings, until now it is one of well-known importance to engineers throughout the world. A complete system of telephonic communication connects the offices with the different departments of the works, and a private wire with tape-printing record instruments at each end connects the Birmingham offices and works with Coombs Wood, the former being in direct communication by private wire with the Post Office. A handsome mess room has recently been erected for the use of the men at meal times, and for social purposes after working hours. This, also, is lighted by the electric light, and heated by hot water. At Messrs. Lloyd and Lloyd's works in Birmingham and elsewhere, some 200 to 300 men are also employed upon the production of boiler tubes and many other kinds of lap-welded tubes and coils of all descriptions.

Messrs. Lloyd and Lloyd were the pioneers in the manufacture and introduction of gas-welded wrought iron and steel tubes of large diameters. At their works the first plant for this purpose was put down, and all the preliminary experiments with the process were made. After several years of costly experimenting they succeeded in its application, and became the first manufacturers of large gas-welded tubes and flues.

Gas welding has, however, been found to be too costly and difficult of application for the manufacture of some classes of large tubes and their accessories; Lloyd and Lloyd therefore turned their attention to electricity as a more reliable and convenient heater, and the results which were shown at their Coombs Wood Works have been obtained by means of the Benardos process, and improvements upon it designed and patented by themselves.

The method of working is a very simple one, and may be thus shortly described:—Three ordinary lighting low tension continuous current dynamos (Crompton) are used, to the terminals of these a battery of Benardos accumulators is connected, and into this the current flows continuously. When the welding circuit is closed the current flows from the dynamo and accumulators through a large regulating resistance. By these means a discharge equal to about twice that of the capacity of the dynamo is obtained, and the load factor of the plant is high. It is possible for some purposes to work without accumulators, by the use of larger resistances, but the efficiency of the plant is not high, because

during part of the working period no current whatever is passing, and the whole plant is running light.

In parallel with the terminals of the dynamo or battery, as many welders or welding machines as may be desired can be connected, and every welder is able independently to vary his current and pressure to suit the work in hand at the moment.

One terminal of the system is connected by means of a flexible cable to a carbon pencil held in an insulated holder, which holder is held by the workman.

The other terminal of the system is connected to the table on which the work lies, or to the work itself.

Thus the carbon pencil forms one pole and the work the other pole, and the electric arc is sprung between them.

Switches, instruments, and cut-outs are interposed in each circuit for the purpose of manipulation.

It is found advisable to work with as long an arc as possible, as the heating effect is, by so doing, more regular and better distributed.

The plant may be readily increased by placing more dynamos, more welders, or more batteries in parallel with the first, the whole system being worked at a constant potential.

It is possible to obtain an arc for welding purposes 6 inches in length, and having a sectional area of about 2 square inches.

When iron, or steel, is under treatment, it is usual to make the carbon the negative pole and the iron or steel the positive pole; for other metals the poles are sometimes reversed. In welding lead, for instance, it is usual to work with the carbon positive.

The face and eyes of the workmen must, in all cases, be protected by means of coloured glass. If the eyes are exposed even momentarily to the full glare of a large arc, an effect is produced upon the muscles of the eye which, though not permanently injurious or of more than a few hours' duration, is disagreeable whilst it lasts.

The accumulators used comprise 1,700 cells, and are manufactured under the Barnardos patents by Lloyd and Lloyd; they are so designed that they may be discharged at a rate which would be ruinous to any pasted plate. A large battery was shown which had been at work for nearly two years, and it had not been necessary to replace a single plate.

One of the principal improvements introduced by Lloyd and Lloyd consists of a mechanical arrangement for distributing the heat of the arc, which is made thereby to gyrate or vibrate at a high rate of speed, and at the same time to travel backwards and forwards over or under a given surface —thus avoiding too great concentration on any one point or line.

In conjunction with this arrangement for heating, a power hammer driven by an electric motor is under the control of the workman, which can be instantaneously brought into operation when the metal is sufficiently heated. To ensure success, rapid working of the heated metal is absolutely necessary.

Three important points had to be considered in estimating the value of the Benardos process—viz., its practicability; the quality of the work done; its relative cost.

The first point has been decided by nearly two years' continuous work at Coombs Wood and a prolonged trial in the works at Newburn, of Messrs. John Spencer and Sons, Limited. The same men are now at work welding who have been associated with the process since its installation. No trouble has ever been experienced in finding men willing to learn to handle the carbon. No welder has ever relinquished the work or suffered in health or sight.

In order that the capabilities of the process in regard to the second and third points might be placed beyond doubt, Mr. Henry Lea, C.E., of Birmingham, was asked to conduct an investigation in conjunction with Messrs. David Kirkaldy and Son, of London. For this purpose, 210 bars of varying thicknesses and qualities of iron and steel were electrically heated and welded by ordinary workmen (not trained smiths), and, together with 50 bars welded by good engine smiths in the employment of another firm out of a coke fire in the usual way, were submitted to Messrs. Kirkaldy to be tested. The "average ratio of weld to solid" of the 150 electrically heated iron bars equalled 85·5 per cent., and of the 60 steel welds 80·8 per cent. In every case 10 welds of each size were tested. A comparison between the results obtained from the hand-welded bars and those which were electrically heated showed that in every case the latter give a higher "ratio of weld to solid" than the former. In other respects, also, the comparison is usually favourable to the electrically heated bars. These experiments are believed to be the first attempt to demonstrate scientifically the value of the arc as a heater of iron and steel for welding purposes. It must be remembered, however, that the results shown were obtained by comparatively unskilled hands, and could be materially improved by continuous practice.

Messrs. Lloyd and Lloyd state that the economy of arc heating in the manufacture at Coombs Wood of the various articles is established beyond doubt.

MR. LEONARD'S LAW OF MOTOR EFFICIENCY.

Mr. H. WARD LEONARD writes to the *Electrical Engineer* of New York as follows:—"In the issue of the *Electrical Engineer* of December 9th,* Mr. C. O. Mailloux, in discussing the law I stated as governing the operation of motors of perfect efficiency, makes some statements which seem to be incorrect and to which I therefore wish to call attention.

"In my article I discussed a motor whose speed and torque must both be varied to meet the conditions of practical work, and stated that to operate efficiently we must

> Vary the voltage as the speed desired,
> Vary the ampères as the torque required;

and I then described a method by which this result should be accomplished.

"Mr. Mailloux finds nothing new in this law and mentions a host of electricians in whose writings it can be found 'more or less amplified.' I think, however, that it will be difficult to find a motor whose speed and torque are both variable which follows the law as stated. In the shunt motor, the ampères are varied as the torque, but the speed is constant; hence, it is not an example. When a rheostat is inserted in the armature circuit of a shunt motor, it is true that that portion of the energy which is utilised in the armature follows the law; but the total energy used does not follow the law at all, for the volts are constant from the line under varying speeds, and the efficiency, instead of being a constant, is directly proportional to the speed.

"Mr. Mailloux is, I think, in error in stating that in the street car motors commonly in use the ampères vary as the torque. Such a condition could only be realised in a constant field and with the series fields commonly in use as a constant field is not realised under varying torques, although the commutation of the field is, of course, an endeavour to approximate to it.

"In commenting on my suggestion as to the grouping of six motor armatures in various relations from series to multiple while in constant fields, Mr. Mailloux says: 'It is scarcely necessary to point out that in this case the torque and speed are both varied and regulated, not by following Mr. Leonard's "law," but by varying the counter-electromotive force. The circuit potential available to the motors may remain constant. The current, on the contrary, will not remain quite constant for all groupings. It is apparent, therefore, that Mr. Leonard's law would be most useful when supplemented by a key to, or list of, its exceptions.'

"It seems to me that in dividing the total initial electromotive force between the six armatures in series and securing one-sixth speed we certainly 'vary the volts as the speed desired;' and I look upon the counter-electromotive force as the *result* of the impressed electromotive force and consequent speed, and not as the *cause* of the speed. Also, there is no question that the current *will* be constant for all groupings, neglecting, of course, the slight effect of the losses in heat, as we do when we speak of a shunt motor as having a constant speed, and a current proportional to the torque.

"Mr. Mailloux says: 'It is perhaps interesting to point out that in the case of an electric car, a continuous current converter, such as described by Mr. Leonard, would add some

* See also last week's REVIEW.

1,500 pounds and two commutators to the car. The objections to the two extra commutators would '"weigh"' if anything *more* than the double machine.' Although 'interesting,' Mr. Mailloux's statement is far from correct, as the additional weight will be between 400 and 500 pounds instead of 1,500. The abhorrence of commutators shown by Mr. Mailloux is explained by his statement: 'The writer has himself devised methods of regulation employing continuous current converters in connection with ordinary *series motors*.'

"When a commutator is subjected to the severe inductive reactions of a series field, and especially with a rheostat also in circuit, it is not to be classed with a commutator on an armature having no rheostat in series and running in a constant shunt field. A commutator which, in the former case, would spark viciously and continuously, will, in the latter case, run absolutely sparklessly and require no more attention than a well-lubricated bearing.

"Mr. Mailloux has been kind enough to grant that my method of operating a motor 'will not be without its sphere of applicability and usefulness,' which practice has already demonstrated in its commercial application to travelling cranes, where the use of series motors with rheostat control of speed has been attended by such serious drawbacks as to cause certain manufacturers of travelling cranes to quickly appreciate the value of a current and torque automatically proportional to the load and a speed perfectly controllable in either direction from zero to the maximum, and also automatically constant at any desired speed regardless of the load."

LONDON COUNTY COUNCIL.

THE following matters were brought forward at a special meeting of the Council, held on Thursday December 17th:—

Subways Bill.

In preparing this Bill we have endeavoured to carry out the resolution of the council on June 9th last, instructing us to prepare a Bill giving the council power to require companies and others to lay their pipes, &c., in the existing subways, and to pay the council a rent for such use. The Bill also, as directed by the council on November 3rd last, contains provisions for giving the council power to make bye-laws and regulations with reference to the use of its subways, existing or hereafter to be constructed, and imposing penalties for the breach of such bye-laws and regulations. We do not, however, think that the Bill is satisfactory. The rights of electric lighting companies as to wires have been recently settled under the Electric Lighting Acts, and as regards all overhead wires the council have large powers of regulation by bye-law under the Act of last session. It is difficult, therefore, to see what case can be made out to justify any disturbance of legislation so recent. On the other hand, unless these wires are to be dealt with, is there a case for *any* Bill. As regards any new subways made under powers of any future Act of Parliament the extent and terms of their use would properly be dealt with by such future Act. As regards existing subways the companies were subjected to no rent by the Acts which authorised them. We have, however, no such detailed information on the difficulties which exist and the precise mode proposed to remedy them as to enable us to express any very decided opinion on the matter. The subject certainly requires careful consideration, as any such Bill must of course be strongly opposed by all the water, gas, electric, telephonic, and other companies and persons having power to lay pipes and wires. However, the references to us do not appear to leave us any discretion as to the advisability or otherwise of proceeding with the matter, and we have accordingly taken the best steps in our power to carry out the instructions of the council. A copy of the Bill has been sent to each member of the council, and we recommend that the Subways Bill be approved; that the seal of the council be affixed to the petition for leave to bring in the Bill; and that the Bill and petition be deposited, pursuant to the Standing Orders of Parliament, with such verbal alterations, if any, as the Parliamentary Committee may consider desirable.

Standard of Light.

On July 28th last the council, on the recommendation of the Sanitary Committee, resolved to introduce a Bill in the next session of Parliament for substituting a more exact standard of light for that now prescribed by the principal Gas Companies' Acts, and referred it to us to take the necessary steps for this purpose. It will be remembered that the Sanitary Committee submitted a further report on this subject on October 13th, referring to the endeavours made to secure the appointment of a scientific committee to consider what the standard of light should be, and stating that in the absence of an authoritative decision on this point, it might be useless to promote a Bill. As the Sanitary Committee were in communication with the Board of Trade we thought it advisable to postpone the consideration of the matter pending a reply from that department. Eventually it was intimated that steps would be taken for the appointment of a Committee, and the Sanitary Committee, at our request, furnished us with a memorandum explaining the object sought to be attained by the Bill, and also sent us the draft of a Bill on the subject. These we referred to the agent, and as time pressed, instructed him to prepare and issue the necessary notice for a private Bill, if he thought such a course desirable and practicable. The agent is quite of opinion that the proper mode of procedure is by a private Bill or Bills to amend the existing Acts of the gas companies, but he has pointed out to us that the whole procedure of private Bill legislation under the standing orders of Parliament is based on the assumption that clear notice should be given of enactments affecting particular interests, and that the Bill should clearly define the enactment required, so that the parties affected may have adequate time and opportunity for considering the case, and stating in detail in their petition to Parliament their objections and arguments against the Bill; and he does not think that any private Bill could be properly framed dealing with this subject, unless the nature of the new tests suggested were described therein. Therefore, as it is impossible to define the standard of light until the proposed committee has reported, the agent thought it better not to publish any notice. We entirely approve the course which he has taken, and we recommend that further action in the direction of obtaining legislative authority for a more exact standard of light be deferred for the present.

REPORT OF THE HIGHWAYS COMMITTEE.

Notices under Electric Lighting Acts and Orders.

We have considered a notice, dated November 24th, 1891, from the Electricity Supply Corporation, of intention to lay mains from the south east corner of Charing Cross Road to, across, and along a part of, St. Martin's Lane, and across and along Garrick Street to the parish boundary of St. Martin's-in-the-Fields. These works are of the same description as those approved by the council on previous notices of this company; and we recommend (*a*) That the sanction of the council be given to the works referred to in the notice dated November 24th, 1891, of the Electricity Supply Corporation upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains shall be laid under the footways wherever it is found practicable to do so; that the concrete floor of the road boxes be made 9 inches thick; that the York stone at the top be 4 inches thick; that the longitudinal girders (if used) in all the boxes be laid on 3-inch stone templates, the full thickness of the brickwork, which shall be 9 inches thick; that the mains for Garrick Street shall be laid in the subway there; that the positions to be occupied by the mains in the subway shall be subject to the approval of the chief engineer of the council; that the work of placing them shall be carried out, and that any damage that may be done to the subway shall be made good, to his satisfaction; and that the boxes at the corner of Garrick Street be placed in such positions as he may direct. (*b*) That the clerk be instructed to forward to the Electricity Supply Corporation a notice requiring it to lay the mains for Garrick Street, referred to in the notice dated November 24th, 1891, in the subway of that thoroughfare.

The same company has applied for the council's sanction to the enlargement of certain of its existing street boxes in the Strand, near the Charing Cross station of the South Eastern Railway Company, from 24 inches square to 30 inches, as shown upon a drawing submitted by the company, the size of the cover remaining, as at present, 24 inches square. We see no objection to this, and we recommend that the sanction of the council be given to the enlargement of the boxes in the manner shown upon the drawing submitted by the Electricity Supply Corporation, on condition that the stone at the top of each box be 9 inches in width instead of 4½ inches, as shown on the drawing.

We have considered a notice, dated December 3rd, 1891, from the Notting Hill Electric Lighting Company of intention to lay service mains to 16, Holland Park, to 26, Pembridge Road, and 41, Kensington Park Gardens. This notice relates to very small works to which there is no objection; and we recommend that the sanction of the council be given to the works referred to in the notice dated December 3rd, 1891, of the Notting Hill Electric Lighting Company, on condition that the company do give two days' notice to the council's chief engineer before commencing the work.

With reference to the laying of service lines from mains already laid, the council has agreed to accept from some other electric lighting companies four days' (instead of one month's) notice; and we are of opinion that this concession may be made to this company also. We accordingly recommend that the Notting Hill Electric Lighting Company be informed that the council will, until it gives notice to the contrary, accept four days' notice (instead of the one month's notice required by the company's order), of the intention to lay service lines from distributing mains already laid; and that the Highways Committee be authorised to deal with such notices on behalf of the council.

We have considered a notice, without date, received on December 4th, 1891, from the Metropolitan Electric Supply Company, of intention to lay mains in Little Wild Street and parts of Great Wild Street and Chapel Place, and a further notice, dated December 5th, 1891, from the same company of intention to lay mains in Fox Court, Gray's Inn Road. These works, which will affect short and unimportant streets, are of the same character as those of this company previously sanctioned by the council; and we recommend that the sanction of the council be given to the works referred to in the two notices of the Metropolitan Electric Supply Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be enclosed in iron pipes or efficient casing, and be laid under the footways wherever it is found practicable to do so; that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable,

and that the outer cover, which shall consist of an iron frame filled in with material to suit the paving, shall be efficiently connected to earth.

The Westminster Electric Supply Corporation has given a notice, dated December 8th, 1891, of intention to lay a main across Old Bond Street, from the corner of Burlington Gardens. To this we see no objection, and accordingly recommend that the sanction of the council be given to the works referred to in the notice dated December 8th, 1891, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works.

We have also to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid.

London Electric Supply Corporation:—November 27th—To 31, St. George's Place; December 1st—309, Borough High Street, and 124, Blackfriars Road; December 4th—243, Regent Street.

St. James and Pall Mall Electric Lighting Company:—November 27th—To 10, Glasshouse Street; December 2nd—210 and 211, Piccadilly, and 66, St. James's Street; December 5th—154, Regent Street; December 7th—96 and 187, Regent Street.

Electricity Supply Corporation:—December 3rd—To Orient Line Company's premises in Cockspur Street; December 7th—To 28, Villiers Street, 7, Haymarket, and United Universities Club, Pall Mall East.

Westminster Electric Supply Corporation:—December 5th—To 217, Regent Street; December 7th—To 27, Dover Street; December 8th—To 94, Eaton Square.

REPORT OF THE OFFICES COMMITTEE.

Extension of the Electric Light.

We have to report that, in connection with the extension of the electric light in the central offices, we have authorised the connection of the new electric lighting circuits with the mains of the two supply companies being put in hand at once; and that we have accepted the estimate of the London Electric Supply Company (£92) for low tension mains from their Red Lion Yard station; and the estimate of Messrs. Mather and Platt for the Electric Supply Association (£81) subject to the cables used being of 600 megohms insulation resistance. The estimated cost of the work has been included in the specification for the installation work, the tenders for which were opened by the council on the 15th instant. We recommend that the course taken be approved.

NEW PATENTS—1891.

21,344. "Improvements in dynamo-electric machine commutator brushes." J. E. SPAGNOLETTI. Dated December 7th.

21,354. "Improvements in apparatus for measuring electric currents." H. ARON. Dated December 7th.

21,363. "An improved electric lift." I. PERAL. Dated December 7th.

21,369. "Improvements in switches for primary or secondary batteries." H. H. LAKE. (Communicated by H. Müller, Germany.) Dated December 7th.

21,379. "Improvements in dynamo-electric machines." A. BERNSTEIN. Dated December 7th.

21,442. "Improvements in secondary or storage batteries." H. H. LAKE. (Communicated by I. L. Roberts, United States.) Dated December 8th. *(Complete.)*

21,448. "Improvements in the manufacture of filaments for incandescent lamps." S. PITT. (Communicated by L. K. Böhm, United States.) Dated December 8th. *(Complete.)*

21,449. "Improvements in switches for electrical purposes." F. G. HOWARD. Dated December 8th. *(Complete.)*

21,476. "Improvements in electric meters." A. G. WATERHOUSE. Dated December 8th. *(Complete.)*

21,505. "Improvements in methods for producing multiphase alternating currents and in apparatus therefor." R. KENNEDY. Dated December 9th.

21,506. "For improvements in and connected with water wheels for producing motive power for electric lighting purposes and hydraulic works on streams or tides." W. G. POTTER. Dated December 9th.

21,541. "An improved method of mechanically strengthening dynamo-electric machine inductors." L. PYKE and E. S. HARRIS. Dated December 9th. *(Complete.)*

21,551. "Improvements in apparatus for the projection of electric light." S. PITT. (Communicated by Sautter, Harlé, and Co., France.) Dated December 9th. *(Complete.)*

21,571. "Improvements in an apparatus for showing the principle of the utilisation of heat as a source of electricity." J. STEVENSON. (Communicated by V. Hirbec, France.) Dated December 10th. *(Complete.)*

21,651. "A new or improved method of making and breaking electric circuits, and of apparatus therefor." W. H. DINGLE and J. M. URQUHART. Dated December 10th.

21,668. "Improvements in electric switches." A. MARR. Dated December 11th.

21,683. "Improvements in electrical visual signalling apparatus." C. E. KELWAY. Dated December 11th.

21,702. "Improvements in and relating to the construction of electrodes of large dimensions for accumulators, and to supporting the same in their cells." W. P. THOMPSON. (Communicated by A. V. Kerckhove, Belgium.) Dated December 11th.

21,720. "Improvements in switches for regulating currents of electricity." J. C. HOWELL and P. E. POWNALL. Dated December 11th.

21,723. "Improved means and appliances connected with electrically regulating the feed of carbons to arc lamps." W. ROUTLEDGE. Dated December 11th.

21,728. "Improvements in electric arc lamps." A. G. WATERHOUSE. Dated December 11th. *(Complete.)*

21,783. "A novel combination of metallic wires to dispense with the use of electro-magnet or solenoid as such in arc lamps." F. J. BEAUMONT. Dated December 12th.

CORRESPONDENCE.

Fire Risks and Insurance Companies.

We should like to open a discussion in your REVIEW on a subject which concerns all electric light contractors, namely, the extent to which we are liable in the event of fire?

As the number of installations carried out by a contractor increases, he naturally asks himself, as he hands over each one to the tender mercies of the butler or the gardener, Is all risk of fire taken off my shoulders by the fire insurance company? and the answer is anything but satisfactory.

With a view to getting a decided answer on this point, we wrote, as per copy enclosed, to all the well-known companies, and many of them in their replies infer that the question would have to be settled in a law court, if the fire could be traced to a neglect of their rules.

Now, having carried out an installation, as far as we know, in accordance with the rules, we get the insurance company's surveyor to inspect and see for himself whether it is so; but we find that he much prefers that we should give him a written statement to the effect that the installation has been carried out in accordance with the company's rules. These rules are sometimes vague. Moreover, when we have lost sight of an installation for a few years, alterations may be made; for instance, larger fuses may be put in without our knowledge, and it would be very difficult for us to prove that we were unaware of this. In fact, the *risk* would in such a case remain with us, and not with the insurance company, although we do not get the benefit of the premium.

We are quite willing to believe that none of the larger companies would shirk the responsibility, but we cannot always dictate to our client as to which company he shall employ, nor have we the means of judging as to the merits of an insurance company.

Unless, therefore, the state of the law on the subject would in any case compel the insurance company to take the risk for which they have received the premium, electric light contractors should inform their clients that if they insure in any of those companies who refuse to give a definite acceptance of risk under all conditions they must do so at their own peril.

We are quite prepared, if desired, to publish the correspondence, in order that your readers may see for themselves how the opinions of the various companies differ.

Drake and Gorham.

December 29th, 1891.

COPY OF LETTER SENT TO INSURANCE COMPANIES.

Dear Sir,—The question has been raised as to whether, in the event of a fire, the contractor would be liable to the insurance company if it were found that any portion of the work had not been carried out in accordance with the rules issued by the company?

As you are aware, a number of rules are issued to electric light contractors, most of them allowing considerable latitude under certain conditions. We, as far as possible, instruct our men to adhere to the particular rules issued by the company in which the house is insured; but we presume that after you have received notice of the introduction of electric light into any house, you will send to inspect it if you think fit, or accept full responsibility of fire.

We wish to have a clear understanding on this point, both with regard to past and future work.

We are, dear Sir, yours faithfully,

DRAKE AND GORHAM.

November 19th, 1891.

available. Cable roads serve their purpose admirably where the gradients are so steep that neither horses nor self-propelled vehicles can mount; but Brixton Hill is not too steep for electricity, it has no rise exceeding 1 in 25, and we have examples of electric tramways where gradients of 1 in 15 are surmounted without difficulty. Therefore, it can scarcely be on account of steep gradients that cable traction has been adopted. Nor has there been any very favourable experience in this country with this mode of propulsion.

The cable tramway at Highgate Hill has been a financial failure, although it had no competition, owing to the severe gradients. There is, however, another cable line at Edinburgh, and one at Birmingham about which we have no reliable data, and we are compelled to look to North America for statistics in this direction. There are in the United States and Canada 3,009 miles of tramways worked by electricity, and only 660 miles operated by cable. This is very significant considering that the cable system had some 10 years' start of the electric system.

Direct information concerning the cost of cable roads has not often been obtainable, but recently the United States Census Bureau published certain statistics, which have not been questioned by any authority, and may therefore be accepted as substantially correct. These statistics refer to 22 electric roads, 45 horse roads, and 10 cable roads. We reproduce some figures from the tables of Mr. J. Badger, as given at the recent Pittsburg Convention, for purposes of comparison, and deduce therefrom conclusions which will convince anyone that cable traction is so expensive in first cost that its adoption can only be justified under exceptional circumstances.

Comparing the investments for road equipment and real estate, taking the average of all the lines quoted by the Census Department, we find that, in round figures, the electric roads cost £7,700 per mile of street length traversed, the horse roads £6,681, and the cable roads involve a mean expenditure of £70,000 per mile of street. This shows that the total permanent investment of electric roads is only about 15 per cent. more than that of the horse tramways, whilst the cable lines cost more than nine times as much as the electric roads; the exact ratio of the investment per mile of street is—horse traction 1·00, electricity 1·152, cable 10·486; consequently the proportional traffic that must be done per mile of street occupied, to pay operating expenses and 6 per cent. on investment, would have to be for the horse line 1·000, electric traction ·852, and cable haulage 5·154. As a matter of fact, the cable lines had by far the greatest amount of traffic, and, indeed, unless the traffic is abnormal, cable tramways do not pay at all. Coming to operating expenses per car mile run, we find the same, exclusive of interest on capital expended, for horse traction 12·16 pence, electric 5·51 pence, and cable 7·06 pence.

We have no intention of depreciating the value of the cable system, for, as pointed out above, it has its special applications where it can be made to pay, and where no other system can be used; but what we wish to point out at this moment is, that we cannot see the reason why the London Tramways Company adopted the cable for Brixton, where the gradients are moderate and the traffic never intense, especially as the line is at present only beginning where the more important horse-car line has its terminus. Even if the cable were extended to Blackfriars or Westminster we doubt whether the amount of traffic and the existing low fares would pay a fair interest on the enormous capital which would have to be invested.

The advocates of the cable line will at once tell us that the hills at Brixton and Streatham are too steep for horses to climb, and that the figures of comparison quoted from American sources refer to electric tramways with overhead conductors, which would not be tolerated by Parliament or municipal authorities in this country. To this we reply that there are well tried methods of electric traction with underground conductors, involving no more interference with the roadway than cable conduits, with the advantage that they are much cheaper in first cost and far more efficient. The Blackpool line has been in operation many years with perfect success, paying good dividends. Going further afield, the Budapest Electric Tramways, traversing the principal streets of that fine city, and covering 20 miles of track, without even the dreaded "third slot," are an unqualified success. They have now 60 electric cars, the working of which costs only 48·5 per cent. of the gross receipts. The energy usefully applied on electric cars amounts to about 50 per cent. of the power given off at the power station. With cable traction more than 25 per cent. efficiency can seldom be relied upon, the bulk of the available energy being absorbed by the many tons of steel cable moving at a constant speed of some 8 miles per hour over hundreds of pulleys, each of which has to be kept carefully lubricated, lest it gets hot and adds to the already enormous waste. The life of such a cable, which is very costly, seldom exceeds twelve months, when it has to be renewed, a process involving some trouble. As the cars cannot start suddenly to their maximum speed, and as they very frequently have to run at a moderate pace, the grip must slip on the rope, and this is the principal cause in the short life of the cable, as well as another waste of power. On electric cars the consumption of current is proportional to the load and to the speed. Accidents with cable cars are more frequent than with electric ones. The entangling of the grip with a broken strand of cable has been the frequent cause of considerable damage to life and property. Reverting to the Budapest tramways, the best examples of the kind we can point out, we are informed that the entire permanent way, together with conduits, drains, feeders, and conductors did not exceed £11,500 per mile.

Viewing the question from all sides, we cannot help asking the question, Why has electricity not been adopted by the London Tramways Company?

ELECTRO-PHYSIOLOGICAL RESEARCH.

ANY attempt to improve the means by which physiologists can study the behaviour of muscle and nerve under the action of electric currents must be welcomed at all times.

Dr. R. Milne Murray seems to have spared no trouble in providing his profession with an apparatus which, from a medical point of view at least, seems eminently suited to their present wants.

Dr. Murray has devised an electrical "bench" for physiological research. Upon it are mounted the necessary arrangements for generating, controlling, and measuring the currents communicated to the muscle or nerve under test.

By various plugs and relays intermittent currents of various known time-rates can be obtained; and the same rotating drum upon which the rate of interruption is recorded has a second *stylus* attachment for noting the moment at which the contraction of the nerve-muscle occurs.

The way in which the current strength is varied appears to us, at first sight, unnecessarily complicated. The battery is connected to the opposite corners of a Wheatstone's bridge, of the slide-wire form. The other corners, those usually going to the galvanometer, are joined to the terminals of the particular apparatus through which it is desired to send the variable current. The required change is produced by sliding the jockey along the stretched wire.

The advantage of this method over a single stretched wire, put in place of the bridge, and having the battery connected to its ends, and the leading-out wires carried from one end of the stretched wire and back to the jockey, was not pointed out by Dr. Murray.

Interruptions of the current are made by mercury contacts, and are regulated by sliding a weight along the vibrating reed. For very accurate work, and especially for medical purposes, mercury is not all that could be desired. Apart from the noxious nature of its fumes, mercury takes up an oscillation on its own account which causes variations in the actual time-rate of making and breaking at the point of contact. Mercury also clogs after a little use, and a fine adjustment is impossible.

In any case a condenser should be inserted, and if hard metallic contacts cannot be employed, a clockwork device would appear preferable.

The measurement of the currents used in these experiments is by no means an easy matter. The only thing to which we call attention, in the galvanometer designed by Dr. Murray for the purpose, is the method by which the needle is damped. The controlling vane is made of aluminium, and is shaped like an arrow head directed downwards, the point dips into oil, or other liquid, in such a way as just to touch the surface, or "skin," of it.

This is said to damp the ordinary motions of the needle, and also to diminish the oscillations caused by external tremors.

It would be interesting to know more precisely what kind of currents Dr. Murray proposes to measure by his galvanometer.

THE RESISTANCE OF EARTH PLATES.

REFERRING to the recent experiments by Mr. Appleyard upon earth plate resistances, of which a full account was published in our columns a few weeks back, an industrial contemporary gives expression to some curious opinions concerning what a telegraph engineer wants to know.

In the first place, a doubt is raised as to "whether there is not some misunderstanding about the necessity for accurate measurements of such things as earth plate resistances;" and, according to their view, "the question the telegraph engineer wants to answer is: 'What pressure will be necessary to produce a given current?' The resistance is one factor, and the disturbing E.M.F. is another, and to determine the resistance alone is of little value, as the disturbing E.M.F. varies from time to time, and is also largely dependent on the current. It would seem more to the point, therefore, to measure the fall of potential over the 'bad contact' with the normal current. Again, the resistance in ohms of the earth of a lightning conductor is no criterion. A lightning conductor, for instance, with a bad metallic contact in it, might give a very high resistance reading, but the bad contact would have no influence on the lightning."

In his criticism of the experiments, the writer seems to have overlooked the two important deductions which Mr. Appleyard has drawn from them. They are:—(1) The constancy of the *initial* resistance of earth plates; and (2) The constancy of the *initial* natural E.M.F. It is by confining himself to these initial values that Mr. Appleyard was enabled to obtain consistent numbers, and it is the special feature of his method that the *initial* resistance and E.M.F. may be measured by it.

We are not quite clear as to what our contemporary means by the statement that "the resistance in ohms of the earth of a lightning conductor is no criterion." No criterion of what? Nor can we follow the sense in which "the bad contact would have no influence on the lightning." To us it would seem that if the bad contact has no influence on the lightning, the sooner it is made good the better, for the lightning *may* influence the bad contact, especially if it is anywhere near a powder mill.

As regards the accuracy required in the measurement of the resistance of such subordinate and mundane things as earth-plates, we can scarcely take exception to Mr. Appleyard's remarks on that score: "We want the truth, but not to the fifth decimal."

Telegraphic Communication with Rock Lighthouses, &c.

THE letter of Mr. R. S. Culley in the *Times* of last Wednesday week is not calculated to forward the question of communication with lighthouses. In summing up the difficulties, we think Mr. Culley is guilty of exaggeration. We are inclined to think that communication *can be* satisfactorily established. Surely if lighthouses can be so built as to stand "with waves running even up to the tops of the towers" (we quote from Mr. Culley), a type of cable can be designed and so laid that it will last under conditions which would seem less severe. Are we to assume that because the one single attempt which has been made to connect up a lighthouse failed that the thing is impracticable? We cannot agree with Mr. Culley as to the difficulties there would be in repairing such cables. He says: "It is possible to repair a cable in the open sea in a favourable situation only in tolerably calm weather." We have heard of a good many successful repairs in *un*favourable situations which have been effected in tolerably *rough* weather. Then, again, he seems to argue that because it is sometimes impossible to communicate with certain lighthouses for weeks it would necessarily be out of the question for a cable ship to work. We once were at the Fastnet Rock, and, although the sea was tolerably calm, found considerable difficulty in landing, and we should say that a cable ship could work a great many days when no communication could be held with this particular lighthouse. Letters such as Mr. Culley's only mislead the public. An engineer's work is to overcome difficulties, not exaggerate them, and if money is only forthcoming there will be no lack of talent and power to successfully utilise it.

VENICE IN LONDON.

THAT Mr. Imre Kiralfy would succeed in producing an interesting entertainment on a gigantic scale, was a foregone conclusion, as all who witnessed "Nero" two years ago readily admitted; but that he would be able to make anything so captivating as "Venice, the Bride of the Sea," was rather doubtful. Yet the author has triumphed, and has brought forward a spectacle the like of which is not to be found in any other part of the world. As far as the opening performance was concerned, several hitches occurred, but this is only natural with novelties, and ought to be especially overlooked with a concern of the size of "Venice in London." The electric light forms an important part in the representation of this large theatrical entertainment, for although no such license has been obtained, yet the spectacle is from beginning to end nothing less than an immense theatrical performance, as Mr. Chapman, the press manager, openly stated. Had the main building been lighted with gas, it would have probably been impossible to see the great spectacle at its best, and many would have been the complaints as to the inadequacy of the illumination. The arrangement of some 48 arc lamps in that building has, however, rendered it almost as light as the open in the daytime; and, in addition to this, "Modern Venice" is lighted by means of a large number of incandescent lamps arranged in a peculiar kind of lantern. The Gülcher (New) Electric Light and Power Company, Limited, of Battersea Foundry, S.W., are the contractors to Messrs. Imre Kiralfy, Limited.

"Venice, the Bride of the Sea," is a grand historic and romantic spectacle and aquatic pageant, entirely due to Mr. Kiralfy for its origination and production, and is now being run by a limited company. It is a combination of some of the historic periods of Italy, and particularly of Venice, in the 14th century, with Shakespeare's "Merchant of Venice." This might be considered somewhat incongruous, but it is really a very good selection. It is divided into two acts, each having three scenes. The interest of spectators was, on the opening day, not greatly awakened until the grand aquatic carnival ballet took place, the dumb representation not being very clear. The aquatic ballet, performed on pontoons floating on the canal in front of the stage, which is 150 yards long, was delightfully interesting. This, and the grand aquatic procession, and the enchanting ballet of the Triumph of Love, constituted the most attractive features of "Venice, the Bride of the Sea."

"Modern Venice" might be described as Venice of to-day transported to London and dropped into Kensington, with its canals, gondolas and gondoliers. Too much praise could not be bestowed upon this gigantic undertaking, which, up to the day of inauguration, is stated to have necessitated an expenditure of £80,000. It would occupy too much space to refer in detail to "Venice in London," which, in Olympia, will doubtless prove very successful, and is well worth a visit.

RING MAGNETS.*

IN the early part of July, 1891, writes Mr. Thos. Henderson in the *Scientific American*, I separated the plates of a compound horseshoe magnet to remagnetise it, and, placing two of the plates on a board, with opposite poles touching, passed the poles of the other plates several times over them. The same process was used, alternately, with all the plates.

On July 13th it occurred to my mind that a study of the closed circuit of magnetism, when the two plates were lying on the table, with opposite poles touching, might open the way to some interesting discoveries. This led to an investigation of the old proposition, that a solid steel ring or circle cannot be magnetised in a circular direction. The usual proofs offered to establish this proposition are: 1st. That it has been tested by trial and found to be true, and, 2nd, that the proposition is self-evident, because there are no points, breaks, or openings, for poles in a continuous or solid ring. Not satisfied with extant theories, the writer commenced a series of experiments in order to be able to demonstrate clearly and positively that the proposition is true, or to show, beyond question, that it is false. The result of these experiments fully establishes the counter proposition, and decisively proves that *a solid steel ring can be circularly magnetised.*

The first step was to have a flat steel bar, one-half inch wide, three-sixteenths thick, and 12 inches long, bent edgewise into a circle, and the two ends solidly welded. While hot and soft, it was sawn at two opposite points, on the flat side, more than half way through its thickness, that it might the more easily be cut into two semi-circles, when cold, and after an attempt had been made to magnetise it. Then, when separated, if the two semi-circular parts were not magnetic, the old proposition would be confirmed. If, on the contrary, any polarity, however feeble, could be observed, acting longitudinally, in the severed pieces, this would be irresistible evidence that the ring had been magnetised.

For obvious reasons, that ring has not yet been divided into two pieces. At each of the marked places, magnetism developed into a corresponding pair of poles, with power sufficient to take up and hold in suspension an eightpenny nail. This settles the question.

Instead of two, had several partial cuts been made in the ring, at each of them polarity would have appeared. The magnetic current passes through every atom of the metal, and only requires an opening to develop its presence. Further trials have revealed the peculiar fact that widening the cut within given limits, not indefinitely, increases the power. It has also been ascertained, by preparing a second ring, that one single cut develops more magnetism than each of two or more.

Pushing the investigation onward, as new paths for exploration came into view, another ring was prepared, similar to the first and second, except that it was not welded. The two ends were nicely dressed and brought into close contact, so as not only to touch but to press tightly together, by the elastic force of the steel. This ring, as were the others, was left untempered, except at the two ends, where it was made very hard. When magnetised, it possessed extraordinary attracting power, at the ends or poles. By a simple device they were made to separate or touch at pleasure. When the opening was from a sixteenth to an eighth of an inch wide, the magnet would lift more than three times its own weight. A ring magnet is certainly stronger than that of any other form, and yet I have never before known that shape to be used. If a number of such plates or rings were bolted together, they would make a surprisingly effective compound magnet.

CONDUIT WIRING.*

BY AUGUSTUS WALL.

THE methods heretofore employed in fitting buildings for electric lighting for future service were at once costly and unsatisfactory. The wires were brought to all the outlets and connected to the main and feeder wires by means of cut-outs or safety devices, grouped in central points; the main feeders were brought to a point in the front of the cellar, and the wires were usually imbedded in the plaster.

After a few years, a lighting company having been organised to supply electricity in any city, the owner applies for connection of his building with their system, under the impression that the only requirement and expense is the small cable which connects the street mains with the main wires in the cellar. He usually receives a report, after his premises have been inspected, that: *The wires are not large enough; or it is wired on the two-wire system, and we require three, or vice versâ, or the lines are grounded, due to the deterioration of the insulation, and numerous other faults.* To remedy these defects, usually, is as expensive and more troublesome than the original work, and the work at best then is "botched." The building, as noted above, was "wired" for so-called "future use," and as shown, it is usually a gamble, as far as satisfactory results

* *Electrical Engineer*, New York.

are concerned. The character of the work is neither permanent nor finished.

By the use of conduits, these defects can be overcome. Instead of "wiring" a building for future use, "conduit it."

The cost is less than one-half; the work is permanent, and can be installed in such a way that in future any system of lighting can be used. The wires need not be installed until there is immediate use for them, and then only in the parts of the building it is intended to light. The insertion of the wire in the conduit can be made quickly and without cutting or defacing the plaster or woodwork in the building.

The conduits should be installed in such manner that the channels will be continuous from the outlets to the cut-out or distributing boxes, thence to the main floor box, and the next end to the front of the cellar. They should be of ample size, and a sufficient number provided to allow placing only one wire in a tube. One or more receptacles, according to the size of the building, should be provided in the walls, and should extend the whole height of the building. The location of these should be central as far as possible.

Angle and fishing boxes should be inserted liberally, for purposes of access, location of cut-outs, and to simplify and make easy the insertion of the wires.

At least two large tubes should be run to each floor in each recess, and in large structures an extra pair should be run in each recess, extending to the top floor. At each floor, and fitted in the recess, should be placed the main floor fishing box, fitted with sockets for the entrance and departure of the tubes, and also fitted with a cover, the surface of which should be flush with the surface of the plastered wall; the smaller boxes being finished in like manner, gives a finished appearance to the work.

In buildings, where the lamps or "points of lighting" are subject to continual changes, such as office buildings, &c., due to subdivision of offices, erection of partitions, &c., a good plan would be to provide a separate feeder for each office, placing the main box on the side-wall, in the corridor and from that box, carry two or more conduits, according to the size or number of lights, on all side-walls of the office, locating the tubes either behind or directly under the cornice, and at certain intervals, insert a box. In these boxes can be located the cut-outs, and all branch or tap connections can be made therein. This will obviate the necessity of defacing the side-walls and ceilings, will simplify the system, and add to its appearance. Should the present tenant vacate the office, the changes in the location of lights, to meet the requirements of the next, can be made quickly, cheaply, and without annoyance, either to the owner or tenant, also without interruption to the lighting system installed in the other offices or public part of the building.

A conduit system installed in this matter will meet the requirements of either the two or the three-wire systems, direct or alternating current, and the electromotive force used can be either 50, 100, or 200 volts; and at the same time, it gives the owner his choice, and does not limit him to the use of any one system, to which his building is fitted, as in the previous methods.

The work, if properly installed, and good materials are used, will be permanent, safe, and cheap.

It is conceded by all experienced in the art of artificial illumination, that the method employed in obtaining it by means of electricity is the safest. It is the aim of all interested in the art, to provide safeguards. The fire underwriters have received our hearty co-operation, and the result of our combined efforts have been such, that at the present time, a building can be fitted for an electric lighting system, which is safe and permanent, and which affords few chances for interruption to a steady light.

The Board of Fire Underwriters insist upon the use of a system of wiring which includes all possible safeguards, but the consumer insists not only upon the use of a system which is free from dangers of fire, shocks, and large bills due to leakage; but also upon a system that will afford steady and uninterrupted light at all times, and for which he is willing to pay.

Every improvement in installation work, either in materials, method, or appurtenances, has increased the cost, yet the work increases in volume every year; electric light is gradually covering the field, to the exclusion of all other artificial illuminants.

Being willing to pay for the best system of "installation work," the consumer is entitled to that which experience has taught us gives the best results in matters of safety, permanence and reliability, and which is in the end the cheapest. This experience will compel us to adopt the "conduit wiring" system, which is conceded by all electrical engineers to be the best; but do we give the consumers the best, even when we adopt the conduit system, and place two wires of different polarity in one tube? Is it the safest, most permanent and reliable?

The conduit manufacturer, when exhibiting his product, inserts wires of different polarity in the tube and in turn, arcs, short circuits, and overloads them, but forgets that the consumer is principally in need of a good lighting system. *It is light, and such light that won't go out*, he wants, and it is reasonable to suppose that if each wire is provided with a separate conduit, the desired result is obtained.

The consumers not only want a safe system, but one that affords very limited chances for short circuits, arcs, &c., and when two wires of different polarity are placed in one tube, these elements of danger and interruption are invited. Two wires placed in a tube and exhibited in a show room may be safe enough, but would any one be rash enough to do so, when installing a plant in a brewery, or in a building where gases are generated? Excessive moisture in the brewery and explosive gases in the other building would, from experience, teach us to provide a conduit for each wire, and, in addition to this, to use only such wire having an insulation of the very highest grade.

The conditions under which the work is placed, comparing the first with the last two noted, are, I admit, extreme; but, comparing the last two with those under which conduit wiring is installed in general practice, are the conditions so dissimilar? In the first, we are confronted by moisture; safeguards are provided against this, not on account of the danger of fire so much as excessive interruptions to the lighting system. In the other, the danger lies in the gases which are generated, and in case of a short circuit, though the metal strip may fuse and break the connection, still an explosion may occur, due to the spark or flash created at the time of short circuiting.

Are not these same conditions met with to a greater or lesser degree in every installation? Is there a building where it can with safety be assumed that the conduits will at all times be absolutely free from moisture and gas?

This can best be answered by the fact that some of the most careful and experienced contractors and electrical engineers throughout the country now insist, upon figuring, on placing only one wire in a tube when asked to submit proposals for installation work. The general results obtained by placing two wires in one tube have been very unsatisfactory and the experience costly. While the first cost is greater when inserting only one wire in a tube, still the annoyance and cost of repairs will in a few years more than offset the difference in first cost between the two methods.

Time has shown that two wires placed in a tube invite short circuits; that the work is unsatisfactory; that the interruptions are of such frequency, that no dependence can be placed on the light; that the work is, to say the least, temporary, and in many cases where the service has been unsatisfactory, a separate conduit for each wire would have obviated the causes thereof.

The gas and water pipes placed in buildings are not supposed to leak, nor is such leakage supposed to enter the conduits used for electric light wires, but it does, and to a very great extent. The moisture which enters may be only a source of annoyance and expense, but the presence of gas is dangerous.

One of the strongest claims that is advanced by the manufacturers of interior conduits in favour of the conduit system is the simplicity, cheapness, and absence of annoyance when making changes in lighting system, or increasing the number of lights on the various circuits.

With the twin conductor system the increase of lights is limited to a great extent. The Board of Fire Underwriters limit the amount of current to be carried on duplex wires inserted in conduits, and should a consumer change from a 100-volt system to a 50-volt system, and at the same time increase his lights, his margin will be very small unless the tubes are unusually large.

That the National Board of Fire Underwriters had misgivings as to the use of twin conductors in a tube, is evidenced from the fact that in their rules (June 10th, 1890) they limit the carrying capacity to five ampères. The committee on wiring appointed by the National Electric Light Association submitted their report at the last meeting (Montreal, September, 1891), and recommended that "Conduits must not be supplied with a twin conductor in a single tube, where a current of more than 10 ampères is expected." From data, which is daily accumulating, I believe it is a matter of only a short time, when its use will be prohibited entirely, and that the "single conduit twin conductor system" will follow in the wake of "undertakers," and other low grade insulated wires.

A system of conduit wiring can be installed that will equal gas piping in permanence, but it can only be done by using the best conduit and the highest grade of insulated wire, and providing a separate duct for each wire.

Experience has taught us that for electric lighting purposes no place is dry enough to permit the use of inferior insulated conductors, and that the best is the cheapest; this applies as equally well to conduits. The conduits are installed under the same conditions as wire, and the same care must be taken.

Some years ago the writer was consulted regarding a large wiring contract by the officer of a lighting company on the matter of insulated wire. The writer suggested the use of a certain insulation which in his opinion has no superior. An electrical engineer who was present suggested the use of inferior grades in such places as small stores, &c., in side streets, claiming that in these cheap places a cheaper wire can be used, and so save money for the company.

The writer answered that it was just in the cheap places that the best wire should be used, the dangers being greater than in the better constructed buildings on the main thoroughfares. That the officer of that company appreciated the importance of using the best grade wire, and that the position then taken by the writer was a strong one, is attested by the fact that to the writer was awarded the contract, in a clause of which it stated "that the contractor was to guarantee the work for a period of one year from the time of turning on the current," and although several years have elapsed there has not been one cent. expended in repairs due to the insulation on the wires. The contract covered all kinds of work, and in all parts of New York City, and included residences, theatres, stables, bakeries, &c.

This officer, while not an electrician, possessed a large business experience, which no doubt taught him that, by protecting his customer, he was protecting his company. Had inferior wire been used no doubt the loss to the company in decreased monthly receipts, due to the interrupted service and the employment of a repair gang, would have more than offset the difference in first cost.

A CURIOUS CASE OF DAMAGE BY LIGHTNING.*

BY ALFRED HANDS, F.R.Met.Soc.

ON the afternoon of Sunday, April 5th, 1891, a severe thunderstorm passed over South Staffordshire, and during Divine Service Christchurch, commonly called the Forest Church, Needwood, was struck by lightning, and some slight damage was done.

I received instructions to examine and test the lightning conductor and report as to the cause of the accident. On examination I found the damage, although only of a trifling character, possessed some points of both an uncommon and instructive character, and I thought, therefore, that a description might be of interest to the Fellows of this Society.

The church, which is a small building having a tower at the western end, stands on high ground, and has several trees round it.

The tower, which has four pinnacles, each surmounted by a small wrought iron vane, is about 64 feet in height, while the ridge of the roof is 34 feet from the ground line. The length of the building without the tower is 60 feet.

The conductors, which had been erected, I believe, about seven years before, consisted of a main down conductor of copper tape 2 inches by $\frac{1}{16}$th of an inch carried from the south-east pinnacle to earth, while each of the other pinnacles had a branch conductor of copper tape 1 inch by $\frac{3}{32}$th of an inch carried to the main down conductor. All these conductors were connected to the vane rods by copper bands made in two halves fastened by copper bolts and nuts, and to these bands the tapes were secured by copper rivets. The earth connection was made by a copper plate 3 feet by 3 feet by $\frac{1}{8}$th inch in accordance with the instructions formulated by the "Lightning Rod Conference."

Unfortunately no one saw the lightning strike the church, the only person in the neighbourhood outside the building at the time being a man who had taken shelter from the rain under a yew tree some 12 feet or 15 feet from the conductor, and he was so placed that he could only see the lower part of the building. We must therefore take our ideas of what occurred by deduction from the traces the discharge left in its course.

The main conductor at its junction to the vane was disconnected, the copper bolts fixing the band or collar and also the copper rivets which connected the tape to the band being broken, but there were no marks of fusion. Further down a spark passed between the conductor and the lead flashing, which runs along the edges of the slates about 2 feet away, damaging the stone parapet in its course. Lower down, a few inches from the ground, a spark passed through the wall into the building. Along the ridge of the roof sheet lead is laid in lengths overlapping one another, and this lead was turned up at every alternate joint. The rain-water gutters along the southern side were broken and thrown down in two places, and the rain-fall pipe at one side of the end of the building was broken at the joints and also thrown down. The corresponding fall pipe on the other side had slight damage at the joints.

The most curious part of the damage, and one which appears to me inexplicable, was on the top of the tower. As usual with such places, it is covered with lead, which was in connection with the lightning conductor. Round each of the four pinnacles there is an iron band with a stay rod of $1\frac{1}{4}$ inch iron from it to the lead flat, where it is secured by a $\frac{3}{8}$ inch iron bolt. The lead is $\frac{1}{16}$th inch in thickness: beneath that there is 1 inch floor boarding, then there is a space of 3 inches, and below that there is a 9-inch rafter through which the bolt rod passes. Just under this stay rod there was a hole about an inch in diameter, made as if it had been punched, the edges of the lead being turned downwards and the wood floor board splintered.

No further damage was done here, but the buttress at the south-east corner of the building was broken through by a discharge which took place between the fall-pipe and the railings on the south side of the church, and further on, where the metal continuity of the railings was broken by a gate being open, a discharge passed through the brick step slightly disarranging it.

On the opposite side of the building there are also railings, and discharges passed from these to earth in three places, cutting channels through the grass.

As previously mentioned, a spark passed into the church at the base of the conductor, and, of course, I at once suspected that there was metal behind there; but I may mention as an instance of how people who do not understand the subject may overlook important details, that I was assured that there was no metal whatever. On examination, however, I found that just inside the wall, which is 18 inches in thickness and therefore within about 2 feet of the conductor, there was fibre matting, the ends of which lying against the wall were bound with lead, about equal in quantity to a 1-inch diameter pipe flattened out. There were two lengths of this binding placed end to end, then there was a break of 4 feet 11 inches, when the binding commenced again and continued past the centre, where there is a step between the tower and the body of the church.

Just at the corner where the spark passed, close to the wall and on the lead was a hassock through which the spark tore its way, driving it 40 feet up the church; then the discharge was conducted by the two lengths of lead binding to where the break occurred. There was a wooden seat which was the

* Read before the Royal Meteorological Society, June 17th, 1891.

next best conductor available, and the discharge passed through the lower part of it, moving it by the impact of the blow 22 inches out from its position. Further on, where the lead bindings commenced again, it left the seat and was conducted to the step, where it struck through the stone to a large iron furnace formerly used for heating the church. This furnace is approximately 3 feet high, 2 feet 6 inches deep, and 2 feet 6 inches wide, and is about an inch in thickness.

As I have said, the whole of the damage was of a trifling character, the hole through the wall being merely large enough to allow of one finger being inserted, and the damage to the step being about the same.

On testing the lightning conductor, I found the connections between the tapes and the vane rods had become bad owing to oxidation, the resistance in one case being over 2,000 ohms. The resistance of the earth connection was 14 ohms.

As regards this resistance to earth, I may say that it is still an undecided question as to what should be the maximum resistance allowable in the earth connection of a lightning conductor. From my experience in testing, I am of opinion that for every five that would be found to have a lower resistance than this, 95 would be found to be higher. It may sound high to electricians who have to deal with electricity at low tension, but for high potential, such as discharge of lightning, it would form comparatively no obstruction. It is such a resistance as would, under ordinary circumstances, be given by a copper plate 3 feet square bedded in coke. Under very favourable circumstances, that is in a very damp locality, I have found that a copper plate this size laid 2 feet under ground, has given a resistance of a fraction of an ohm merely, while in a light porous soil I have known a plate 10 feet by 3 feet 6 inches, at a depth of 10 feet, show a resistance of 30 ohms.

Undoubtedly a resistance of half an ohm is better than two ohms; but in a case such as this, where there are no gas or water pipes, or other metals having a low resistance to earth, such a small resistance as 14 ohms cannot be considered sufficient to explain a flash passing from the conductor to other metals.

If it was absolutely necessary for the "earth" to be below 14 ohms, then at least 95 per cent. of the conductors in England would have to be condemned as inefficient. Personally, I think that the question of the maximum resistance allowable depends upon what other paths to earth are available. For instance, a plain stone structure, without a particle of conducting matter in its composition besides the lightning conductor, would be protected by a comparatively high resistance; while one with gas and water pipes, which necessarily have admirable earth connections, should have a conductor with a nominal resistance only.

I have for a long time considered that it is possible that where a conductor is carried close to metals either inside or outside a building, that a spark may pass, no matter how low the resistance to earth; indeed, it is obvious that the "Lightning Rod Conference" took this possibility into account when they recommended that all metals in the neighbourhood of the conductor should be brought into metallic contact with it. Great care, therefore, should be taken by those fixing conductors to see that they are not placed near any other metals, either inside or outside the buildings, which it may not be convenient or expedient to connect them to, and the owners of the buildings should take care that no metals are placed in the neighbourhood of the conductors after they are fixed.

In the present case there was in the vault under the tower a large mass of iron. This would have been perfectly safe, but that a line of metal had been recently laid from close to this furnace to within about 2 feet of the conductor, and this was equivalent to reducing the distance between the furnace and the conductor very considerably.

At the time that the conductor received the discharge of lightning, the copper tape and the metals inside the church would, owing to inductive action, be in oppositely electrified states, and consequently a spark would pass to restore the equilibrium.

It is extremely difficult to say what exactly was the nature of the discharge at Needwood Church; but I am convinced by several details that it was exceptionally severe. There are circumstances pointing strongly to an upward discharge of lightning, but this is not fully borne out; while the remark of the man I have referred to that he saw a large ball of fire come down the tower, might lead us to imagine that the phenomena might be connected with "globular" lightning.

After a careful examination of the building, I am inclined to think that it was either struck by two flashes simultaneously, or by a discharge which bifurcated, part falling on the south-east pinnacle of the tower, and part on the ridge of the roof. The first part was conducted down the copper tape to earth, but a spark passed through the wall to the binding of the matting, as I have already described. The other part divided, part passed along the lead on the roof, and sparked across the parapet to get to the conductor, the remainder going to earth by the rain-water gutters and fall pipes; but it is evident that nearly all passed down on the south, and very little on the north side. It was raining heavily at the time, and no doubt water had penetrated under the lead at the joints along the ridge, so that the heat generated by the resistance at the joints might turn the water into steam, and so blow up the edges by the force of the explosion.

The damage to the rain-water pipes and gutters would probably occur in a slightly different way. This kind of damage takes place in nearly every case where rain-water pipes act either as conductors or auxiliary conductors to a flash of lightning, and I have heard several explanations, but none that seem quite feasible. It should be borne in mind that the gutters and pipes are badly put together, no attempt being made to make the joints electrically good; in fact, there is an enormous resistance in some of them almost from the moment they are put up. There is sure though to be one point in each of the joints where the resistance is less than in the rest of the joint, and an electric discharge, in passing from one length of pipe or gutter to the next, chooses this path of least resistance, and passes across in the form of a spark, so generating heat at this point, and this heat is so great and is generated in such an inconceivably short space of time, that before it can be conducted along the metal, expansion takes place at one part, which, as the metal is brittle, causes the iron to crack, and the piece broken off springs away to a distance. I have often tried to find one of the pieces to look for marks of fusion, but have never been successful, as they are probably projected to too great a distance. In this case I found one piece of gutter which, although it was not broken, shows signs of fusion such as I expected.

The discharge that took place at the back of the church between the rainfall pipe and the iron railings is, I think, explicable in precisely the same way as the spark which passes between the conductor and the furnace inside the tower. In this case the rainfall pipe was acting as a lightning conductor, but with a bad earth connection, the resistance to earth being over 1,100 ohms.

In each of these cases of side flash I consider it is as correct to say that sparks passed from the isolated masses of metal to the conductors, as it is to say that they passed the other way; indeed, in the case of the last named discharge, the injury to the rainfall pipe (if really caused by lightning) seems to prove that the discharge was from the railings, and was therefore entirely an induced discharge, and did not exactly form part of the lightning flash.

On the other side it is to be remarked that the railings, although precisely the same distance from the fall pipe on that side, did not receive a spark from the pipe. Hence the charge that passed down this side must have been much less than on the south side. As may be expected, the earth connection of this fall pipe was even worse than the other.

There would, however, still be the induced charge in these railings to be got rid of and consequently on this charge being liberated, it would go direct to earth, cutting the curious furrows in the grass which I have described. I take the intensity of this induced charge to be a proof of the exceptional violence of the inducing charge.

The lightning conductor could not be passed as in a satisfactory condition, owing to the bad joints at the connections to the vanes. Besides this, there were some bad bends, the tape being carried down from the pinnacle to the lead flat and then up again over the parapet. Again, the conductor ought to have been connected to the lead flashing on the roof where it was carried near it.

I contend, however, that none of these faults were sufficient to account for the spark that passed, and that the sole

cause of the discharge there was the lead-bound matting having been laid so close to the conductor.

Although the accident to Needwood Church may be considered to be a case of the partial failure of a lightning conductor, it must be borne in mind that it carried off the bulk of a discharge which, had there been no conductor, would have probably wrecked the tower and caused serious loss of life by the masonry falling through the roof upon the congregation. As it was, the whole of the damage would be set right by the expenditure of a few pounds, and would be covered by the insurance policy.

As regards the body of the church, we may consider that it was never protected from lightning. No expert would say that a conductor on the tower, however perfect, would afford absolute protection to the other end of the church. As a rule, however, those having the management of such buildings prefer to protect the tower or spire, which is the part most likely to be struck, and leave the rest to chance, owing to the extra cost which would be entailed by completely protecting the whole building.

Of course, where there are rain-water pipes and gutters on the building, a discharge of lightning must divide itself between them and the conductor in proportion to their respective capacities; and, therefore, unless the joints were made electrically good, or continuous conductors were carried along them in order to bridge the points of resistance, there is always a danger of some of them being broken. Such very slight damage as this, however, need scarcely be considered, I think, when we take into account the dreadful havoc and ruin which lightning conductors, properly applied and fitted, will prevent.

DISCUSSION.

Mr. SYMONS said that a case of damage by lightning bearing a very close resemblance to that which had been so thoroughly discussed by Mr. Hands, was to be found in the Report of the Lightning Rod Conference (p. 217). In that instance Carmarthen Church, which was provided with a conductor, was damaged by lightning, and the disruptive discharges which caused the damage were due to the conductor being placed in close proximity to a gas main, but not connected with it, the lightning in its passage down the conductor naturally glanced off to the gas-pipe because it formed a good earth. The conductor, however, as in the case described by Mr. Hands, doubtless saved the church from very serious damage. It was one of the recommendations of the Lightning Rod Conference that all the metal work in a building should be in perfect connection with the lightning conductor. In erecting a lightning conductor it was absolutely necessary that every part of the work should be thoroughly well done. He agreed with Mr. Hands that the present case was not an instance of the occurrence of ball lightning, and that the east end of the church was not in the area of protection afforded by the lightning conductor.

Prof. MASCART remarked that the resistance of 14 ohms was far too great, and that it was desirable to utilise gas and water mains in forming the earth connection for lightning conductors. In France it was now the common practice to substitute a long tube buried in the earth for the small plate, usually employed in England, as the earth connection. The lightning conductors fixed on the Eiffel Tower were provided with tubes 100 metres long, buried so deeply in the soil that they were always damp.

Mr. ELLIS said that this paper formed an excellent object lesson to himself, as he was now concerned in putting a new lightning conductor to the parish church at Greenwich, and had received valuable information from Mr. Hands' clear account of the damage done to the church at Needwood. It was a comforting thing to find that even an imperfect conductor might, to a great extent, do its duty The old conductor on Greenwich Church had been carefully examined, the connections and joints were found to be in a bad condition, and the conductor was about to be entirely renewed.

Mr. DINES drew attention to the case of a well-known abbey in England where the end of the lightning conductor was immersed in water in a sealed iron tube buried in the ground.

Mr. STANLEY said that in tropical countries iron rods about 1½ inches in diameter were preferred to copper band lightning conductors. The terminals were pointed brass rods, tipped with platinum. He did not know which metal formed the best conductor under the conditions, but iron was probably cheaper. In the case of damage described by Mr. Hands, it seemed that the electrical discharge was too great for the conductor to efficiently carry it off.

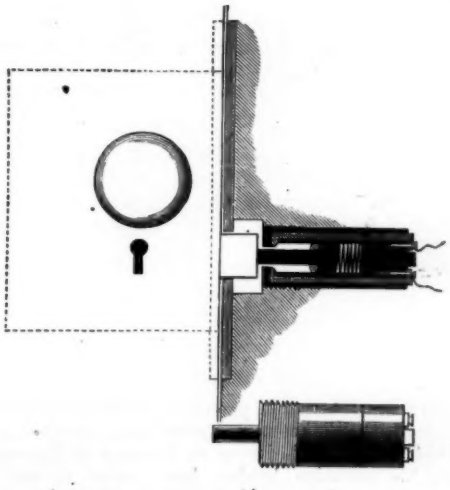
Mr. SYMONS said that he was not prepared to discuss the relative merits of iron and copper as lightning conductors, but doubtless the reason that copper was not used in the countries referred to by Mr. Stanley was because, being of greater value than iron, it was much more likely to be stolen. An iron conductor afforded for the same outlay a larger surface than a copper one, but in a damp atmosphere like that of the British Isles iron rapidly rusted and soon spoiled.

The PRESIDENT (Mr. Baldwin Latham) said that in India iron was almost universally used for lightning conductors, chiefly because the natives stole copper. He much preferred a strip of copper to a rod of iron. In the case of tall chimney shafts a lightning conductor did not give an immunity from lightning stroke, and considering the large amount of iron, such as boilers and furnaces, which was usually to be found in large works, and generally unconnected with the conductor, he was surprised that cases of damage from lightning were not much more frequent.

Mr. HANDS, in reply, said that he thought it would not be possible to connect all metal work inside and outside a building with the lightning conductor. The better way would be to examine the interior of a building first, to ascertain the amount and position of the metal work, and then arrange that the conductor should be placed at a sufficient distance from such metallic substances. He could not agree with Prof. Mascart that the resistance of the earth connection should be less than one ohm, as in districts with a naturally dry soil the cost of carrying the conductor to a sufficient depth to obtain such a resistance would be greater than anybody would care to incur.

SUGGESTIVE TO HOTEL PROPRIETORS.*

"PUT out the light when you leave the room" are the words of an injunction which, if there was any chance of its being obeyed, would be posted by that long-suffering individual, the hotel proprietor, in every room of his house. But as long as there are rooms, and lights which have to be put out, just so long will many of the careless people which the world is so full of leave them burning. It was this peculiar failing of weak humanity that led E. J. Hodgson and J. W. Stearns, jun., of Denver, Colo., to devise a method of controlling the incandescent electric light circuit of hotel apartments, by the shooting or withdrawing of the bolt of the door. It is the hope of the inventors to prevent by their method the burning of the lamps in cases where by inadvertence or mistake the occupant had left his room without turning off the lamps. The details of the device through which they expect to accomplish their purpose is shown in the accompanying cut.



As will be readily seen, the essential mechanism by which the lights are controlled is set in the door frame. The switch proper is nothing more than a plunger so arranged within a cylindrical shell carrying the necessary contacts, that the shooting of the bolt in locking the door forces the plunger to the position indicated, and breaks the circuit, and so extinguishes the lights.

It is supposed that in shooting the bolt it will be done from the outside of the door by turning the key in the usual way. As soon as the door is unlocked or the bolt withdrawn, the circuit is again established, and the lights in the room turned on.

The fastening of the door from the inside may be by a sliding bolt or by another key-actuated bolt manipulated through another key-hole. While the practicability of the invention as here described may be questioned, the idea embodied is suggestive.

* *Western Electrician.*

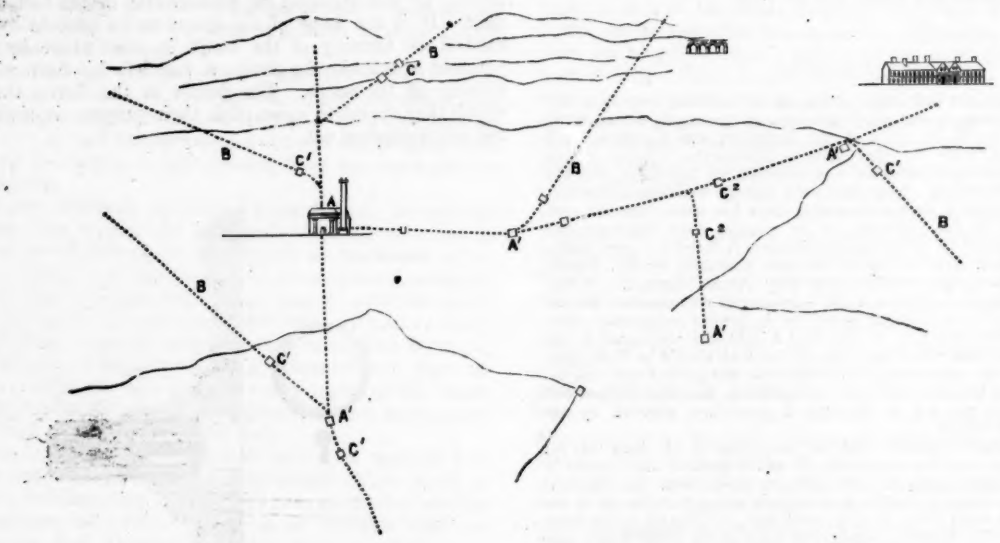
THE INVENTIONS OF HENRY PINKUS OF PENNSYLVANIA.

He anticipates the Electric Transmission of Energy, Central Station Electric Lighting and Systems of Propelling Cars, Boats, and Agricultural Machinery by Electricity more than Fifty Years Ago.

BY A. M. TANNER.

LES Yankees ces premiers mécaniciens du monde, sont ingenieurs, comme les Italiens sont musiciens et les Allemands métaphysiciens—de naissance. With these words of Jules Verne the writer introduces to general public notice one of the most ingenious and versatile inventors of the nineteenth century—Henry Pinkus, of Pennsylvania. Nearly 70 years ago he left his native city, Philadelphia, to seek his fortune in Europe. It was at a period when American industries had not risen to the magnitude of to-day, and the mother country was considered a better vantage field for making progress in the world. In the year 1827 we find that Henry Pinkus was residing at the Quadrant Hotel, Regent Street, London, and it is at this time that he first showed to the world his versatility as an inventor. The subject of producing coal gas for illuminating purposes was then the topic of the day, and our young Philadelphian obtained several British patents for inventions relating to processes for producing and purifying carburetted hydrogen gas, viz., No. 5,569, of 1827, and No. 5,926, of 1830. Whether he practically worked these processes is not recorded. Pinkus now appears upon the scene in the years 1834 to 1839, inclusive, as an inventor of atmospheric railways, his attention having been called to this subject by the work of Vallance in 1824, and the records of the British Patent Office show that he procured patents for inventions relating to this subject, viz.: No. 6,570 of 1835, No. 6,885 of 1835, and 8,207 of 1839. One of the systems patented by Pinkus was carried into practical operation and public use on the Dublin and Dalkley railway, in Ireland, and together with Vallance, Clegg and Samuda, Pinkus is to be considered a pioneer in atmospheric railway work. The subject of wood paving was also attracting considerable attention both in England and France about the year 1840, and hence we find Pinkus enrolled in the list of patentees of wooden pavements, viz.: No. 8,663 of 1840. About this period Pinkus also finds time to experiment with a method of lighting coal mines with gas, and the London *Journal of Arts and Sciences* calls attention to the fact that Mr. Pinkus, of Philadelphia, has been engaged for some time in maturing a method of lighting mines with gas, and hopes by his improved plans to prevent the possibility of explosion from the presence of what is called fire damp. Pinkus, in this method, proposes the employment of an "incandescent flame," by admitting gas and air under equal pressure, into a hermetically sealed glass chamber containing zirconium points, the ignition to be effected by electric sparks produced by electrodes leading into the "sealed lamp." It will be seen that this method was the forerunner of the now so generally known methods of incandescent gas lighting devised by Clamond and Welsbach.

Between the years 1835 and 1840, the subject of the application of electricity as a motive power is brought to general public notice in both hemispheres—Jacobi in Russia, Davenport in America, and Wagner in Germany, by their public experiments, show to the world that electro-magnetism can be industrially applied, and railway cars, boats and printing presses are driven by the new motive power. The journals—both scientific and political—of Europe and America, bring sensational accounts of how electricity is to supersede steam, air, and other forces. The German parliament goes so far as to award a large money premium to Wagner; the Czar of Russia also gives pecuniary assistance to Jacobi, and the experiments on the Neva are proclaimed to the world. In the United States, Davenport, "the Brandon blacksmith," is valiantly at work endeavouring to convince the public that the "murderous age of steam" is at an end. His enthusiasm goes so far as to call into service his wife's silk dress for insulating the magnet coils. He constructs electric motors of all kinds, invents the solenoid electric motor, the credit of the invention of which is generally given to Prof. Page; he experiences the hardships of an inventor who falls into the hands of "patent promoters," and ends by dying disappointed and poor. In the years 1838 to 1840 the agents of Davenport are in England and France; our young Philadelphian meets his countrymen; he witnesses their public experiments with electric motors, and his inventive mind is now diverted to the subject of the industrial applications of electricity.



Naturally his first thought is that electricity could be used as the propelling force on railways, and that the same general arrangement used in connection with certain types of atmospheric railways patented by him could also be applied to electricity. A versatile and far-seeing inventor like Pinkus was well aware that the problem of electric propulsion on railways could not be solved by carrying heavy electric batteries on the car or on the train, as proposed by Davenport, Davidson and others. Similating an electric railway system to his previously proposed atmospheric railway system, where air motors mounted on car axles are supplied with air from a conduit along the track by a travelling air take up device on the car, he evolves from his fertile mind the system patented in England under his own name on September 24th, 1840, No. 8,644, and in France he entrusts the procuration of a patent for the same invention to the Consul of the United States at Paris, Thomas Carroll Brent, who obtains a patent, or rather a certificate of addition to a

former patent of July 26th, 1841. These patents—both the English and French—when carefully studied, clearly disclose an electric railway system with a central station generator of electricity, continuous line conductors constituting the electric circuit, and a travelling contact device for supplying current to the propelling motor on the car. The same patents also set forth the fundamental features of all modern systems of distributing electricity from a central station for the production of light and motive power at points distant from the generator or source of electricity; they also show that the propulsion and towing of boats on canals was contemplated. The patents even go further, because they disclose an electric tillage system, substantially the same as that carried into practical operation at Sermaize some 38 years later. In order to base all assertions thus made upon facts, the description is given almost verbatim from the specification of the English patent, No. 8,644, of 1840, which, it may be stated, is very voluminous, and also contains descriptions of systems of propulsion by air and gases. In order to establish the connection of the French patent of Brent with the prior English patent of Pinkus, the *fac simile* of the American Consul's letter, accompanying the filing of the application, is given :—

Consulate of the United States of America, Paris.

Monsieur le Secrétaire d'Etat Ministre du Commerce.

Monsieur le Ministre,—En qualité d'executeur testamentaire du feu M. Daniel Brent, en dernier lieu Consul du Etats Unis d'Amérique à Paris, et administrateur *ex officis* de la succession. Je viens vous solliciter de m'accorder un brevet de perfectionnement et d'addition au brevet d'importation déposé le 7 Mai, 1840, et accordé le 7 Octobre, même année au sus dit Daniel Brent, pour quinze ans, "pour un nouveau moteur, applicable à l'agriculture et aux transports sur chemins de fer, canaux, et routes ordinaires.

A l'effet de cette demande, j'ai rempli toutes les conditions et formalités requises par la loi.

J'ai l'honneur, Monsieur le Ministre,
d'Etre avec la plus haute consideration,
Votre très humble serviteur,

JOHN CARROLL BRENT,
Consul ad interim, &c.

Paris, Rue de la Victoire, 20, ce 10 Avril, 1841.

This letter shows that a "patent of importation" is asked for in France which indicates that the same invention had previously been patented in another country. Moreover, the drawings of the French patent are nearly the same as those of the English patent, and the description is clearly a translation of the English one. The French drawings, however, have the circuit connections better delineated than the drawings of the English patent, and hence they will be used to accompany the description extracted from the English specification. Exact reproductions of the original drawings on a reduced scale are first given in connection with the description, and then other drawings are added to illustrate what is warranted by the description. These drawings are respectively marked "From original" and "From description."

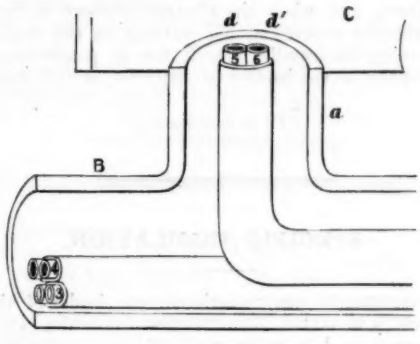
The first portion of the English patent specification referring to electricity is on page 3. It is as follows, viz. :—

Fifthly, I effect impulsion or propulsion on and along railways, common ways, and canals, and over, along, or through fields, by inducing or generating a well known source of motive power, force, or influence, being electrical, whether electro-magnetic, voltaic, frictional, or otherwise. These, or any of them, I supply from stationary wells or batteries, whence I transfer or transmit the motive influence along a line of railway, common way, canal or field, to put in motion apparatus, and impelling machinery consequent upon the combination of method and apparatus hereinafter mentioned, and effect the other things hereinafter described.

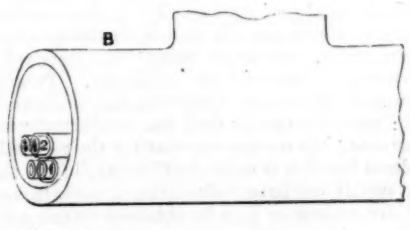
The next portion of the specification reproduced here is a description, commencing on page 11, of the electric tillage system, termed by Pinkus, "A New Agrarian System," according to a prospectus printed in London in the year 1840, and deposited in the library of the Great Seal Patent Office.

ELECTRIC TILLAGE SYSTEM.

"The power or influence which I apply is the electric influence, in any of the forms which I may find most convenient by any of the well known methods of inducing the electric currents, whether voltaic, electro-magnetic, frictional, or otherwise, and whose induction, tension or influence may be transferred, transmitted, or induced at points or places distant from prime sources or batteries. One of the objects to which I apply said motive force or influence is to put engines, apparatus, machinery and implements in motion in, along, over, or through fields for agricultural purposes. With that view, I erect in any given area of land, say, one or more square miles of land, a station, A (drawing 5), placed in a central or any convenient position.



A is a building in which I construct and place an electric battery or batteries of any of the common or well known constructions, or I construct wells or tanks, A, A1, in any part or parts of such area of any suitable material, or any required size and form; these I place under the surface level, the tops of which are so far below the surface as that they may be covered up with soil, so as not to interfere or impede agricultural operations. From the station, A, or the stations, A, A1, I lay down a system of mains or pipes, B, B, B, B, of the diameter of about 2 or 3 inches, united by flanged joints connected in the common manner; these may be laid through various fields either below or above the drainage, and in any direction, as shown by the dotted lines passing through B, one of said mains, B. One is uncovered, to show its position under the surface level. All along said mains, at convenient intervals of from one to two hundred yards, I erect short vertical branches, *a*, *a*, *a*, *a*, communicating with the pipes, B; these terminate in a box, *c*, *c*, *c*, *c*, having a movable lid; the top of the box to be so far below the surface level as not to interfere with tillage. From the station, A, or from the wells, A1, I lead through the pipes, B, continuous metallic wires, rods, or ribands, or bundles of fine wires (as shown at 1, 2, 3, 4, 5, 6, drawing No. 6), say of copper of any required thicknesses or surfaces. The wires, rods, ribands, or bundles



may be insulated by silk and varnished in the common manner, so that one wire, rod, riband, or bundle shall not be in contact with another.

These may be laid in pairs, and coloured with different colours—for example, black and red, blue and yellow, brown and green—the black and red corresponding with the positive and negative poles of the battery; and, in like manner, the blue and yellow, and the brown and green, and so on, for any other pairs and colours. Any pair so arranged may be turned into the vertical branch or branches, *a*, and terminate in the box or boxes, *c*, in which they may diverge, and be fixed at points, *d*, *d*. The apex of *d* may be sufficiently long to bend over to d^1, with which it may be brought in contact by a screw, and from which it may be released at will. A similar arrangement is made in all the boxes, *c*. All the said wires, rods, ribands, or bundles must be so properly arranged, and be so continuous, as that when connected in the boxes, or the pairs united with any other wires connected with ap-

paratus or machinery, and their ends at the stations or wells are brought into proper contact with the positive and negative poles of a battery; they shall form or constitute proper metallic circuits. The wires, rods, ribands, or bundles may be of any desired dimensions suited to convey by their means the largest intensity, effect, or influence, or what is called an electric current, when the wires and battery are properly arranged for conveying or communicating the electric force, and when the electric influence is continued under induction or tension, and so long as the ends of the wires forming the metallic circuit are in proper connection with the poles of the battery or batteries at the stations, A or A1.

(To be continued.)

SPECIFIC INSULATION.

WITH reference to our remarks in our leader of the 18th ult., in which we stated that "at first the real meaning will not be grasped, but experience will soon make it clear." (This with reference to the value of expressing insulation in specific terms, and not in megohms per mile), we have recently received some tests of insulated wire which strikingly show the utility of the change advocated by Mr. Preece, and in which we concurred.

The tests we refer to are as follows :—

TESTS AND PARTICULARS OF VULCANISED RUBBER CABLES.

Gauge of wire.	Dimensions of core.			Insulation per mile at 60° Fahr.	Specific insulation, Mr. W. H. Preece's (σ) formula.
	Wire d.	Thickness of insulation.	Diameter D.		
	Inches.	Inches.	Inches.	Megohms.	
7/22	·084	·078	·240	22,500	21·7
7/16	·192	·057	·306	11,250	24·4

Now anyone glancing at these tests would at first sight say that the insulation of the 7/16 wire was very inferior to that of the 7/22. What are, however, the facts as indicated by the specific insulation results ? Why that the second wire instead of being inferior to the first is actually superior to it, the specific insulation being higher, *i.e.*, the insulating material better. The reason is not apparent until the relative diameters and thicknesses are considered, and then the true value of the insulation will be noticed.

There seems no objection to specifying what the insulation in megohms of a wire must be so long as the specific insulation is also given, the latter being the standard which indicates the true value of the insulation. Practically a similar course is taken when specifying the conductivity of a conductor ; thus we specify that the conductivity shall be, say, 98 per cent., but we also say that for the particular wire to be tendered for this is equivalent to, say, 11·25 ohms per mile. To specify the latter value alone is not sufficient since the particular resistance may be obtained by using a rather large wire of low conductivity, which is objectionable. Specify both conductivity and resistance, and we at once fix the manufacturer ; in the same way specify specific insulation and also megohms per mile for thickness of insulation and we are equally safe.

"MASSAGE" WITH CURRENTS OF HIGH FREQUENCY.*

BY NIKOLA TESLA.

I TRUST that the present brief communication will not be interpreted by the readers of the *Electrical Engineer* as an effort on my part to put myself on record as a "patent medicine" man, for a serious worker cannot despise anything more than the misuse and abuse of electricity, which we have frequent occasion to witness. My remarks are elicited by the lively interest which prominent medical practitioners evince at every real advance in electrical investigation. The progress in recent years has been so great, that every electrician and electrical engineer is confident that electricity will become the means of accomplishing many things that have been heretofore, with our existing knowledge, deemed impossible. No wonder then that progressive physicians also should expect to find in it a powerful tool and help in new curative processes.

Since I had the honour to bring before the American Institute of Electrical Engineers some results in utilising alternating currents of high tension, I have received many letters from noted physicians inquiring as to the physical effects of such currents of high frequency. It may be remembered that I then demonstrated that a body perfectly well insulated in air can be heated by simply connecting it with a source of rapidly alternating high potential. The heating in this case is due in all probability to the bombardment of the body by air, or possibly by some other medium, which is molecular or atomic in construction, and the presence of which has so far escaped our analysis—for, according to my ideas, the true ether radiation, with such frequencies as even a few millions per second must be very small. This body may be a good conductor or it may be a very poor conductor of electricity with little change in the result. The human body is, in such a case, a fine conductor, and if a person insulated in a room, or no matter where, is brought into contact with such a source of rapidly alternating high potential, the skin is heated by bombardment. It is a mere question of the dimensions and character of the apparatus to produce any degree of heating desired.

It has occurred to me whether, with such apparatus properly prepared, it would not be possible for a skilled physician to find in it a means for the effective treatment of various types of disease. The heating will, of course, be superficial, that is, on the skin, and would result, whether the person operated on were in bed or walking around a room, whether dressed in thick clothes or whether reduced to nakedness. In fact, to put it broadly, it is conceivable that a person entirely nude at the North Pole might keep himself comfortably warm in this manner.

Without vouching for all the results, which must, of course, be determined by experience and observation, I can at least warrant the fact that heating would occur by the use of this method of subjecting the human body to bombardment by alternating currents of high potential and frequency such as I have long worked with. It is only reasonable to expect that some of the novel effects will be wholly different from those obtainable with the old familiar therapeutic methods generally used. Whether they would all be beneficial or not remains to be proved.

Effect of Electrification upon the Condensation of Steam.—The following is an account of an experiment made recently by Mr. Shelford Bidwell, M.A., F.R.S., showing the effect of electrification upon the condensation of steam :—"Water is boiled in a small tin bottle, furnished with a cork through which passes a glass tube terminating in a nozzle of about $\frac{1}{16}$th inch aperature. The shadow of the steam as it issues from the nozzle, when cast upon a white screen by a powerful light, appears under ordinary conditions to be of feeble intensity and of a neutral grey tint, showing that the steam is nearly transparent. But if a discharge of electricity is directed upon the base of the jet of steam by means of a bundle of needle points in connection with an influence machine, the shadow at once becomes dark and dense, at the same time assuming, especially near its edges, a peculiar orange-brown hue. The electrical discharge appears to act by promoting coalescence of the exceedingly minute particles of water contained in the jet, thus forming drops large enough to obstruct the more refrangible rays of light. The experiment suggests a possible explanation of the intense darkness of thunder clouds, as well as of the lurid yellow glow by which such clouds are often distinguished.

* *Electrical Engineer*, of New York.

TELEGRAPHIC COMMUNICATION WITH ROCK LIGHTHOUSES.

WE hear that Lord Salisbury, in reply to earnest representations made to him on the subject, has given an assurance that, should the members of Parliament who for years past have unavailingly asked for the appointment of a Select Committee to enquire into the subject of electrical communication between the shore and lighthouses, renew their request during the ensuing session, the Government will offer no opposition to the proposal.

This will undoubtedly be a step in the right direction, and we shall look forward to seeing, at no very distant date, communication established with at least the principal of our rock lighthouses. The enormous advantages to be gained by this are unquestionable, and as they have been prominently brought to public notice of late, we need not refer to them here.

It is not so much a question of the weight of the cable, as Mr. Culley thinks (*vide* p. 28), but of its weight in water and tensile strength, considered in relation to the surface exposed to the waves. In most cases the question of damage by anchors can be dismissed altogether, the lighthouse being itself the protection. The advantage of a heavy inflexible cable under these circumstances is exceedingly doubtful, and we should be inclined to advocate a type so constructed, both as regards core and armour, as to obtain the highest specific gravity possible with the greatest flexibility.

Communication need not depend on one single cable. Three or more short cables of approved construction could be laid separately on the most sheltered sides of the rock, and secured to it. At the first suitable piece of ground these special cables could be brought together, and united to one main cable. It is very unlikely that all these short special cables would be broken together, since three sides of a rock cannot all at the same time be exposed to a storm, and so long as one lasted communication could be maintained. The main cable to shore could be of the ordinary kind, and would be no more liable to interruption than any of the numerous cables about our coast.

GOVERNMENT TELEGRAPHS.

MOST of our readers will, no doubt, recollect a certain Count Smorltork whom Dickens introduces in "Pickwick," and who, after a residence of "one week" in England, considers that he has collected sufficient information to write a voluminous and accurate account of English life and character. We are reminded of this individual on reading Mr. E. Rosewater's address before the New York Electric Club, judging from the accuracy of his statements with reference to the telegraph system in England—not that we have to complain of any attempt to belittle the work done here—but the inaccuracy shown makes the author's statements of very reduced value. It is said, to commence with, that the pneumatic tube department handles the bulk of the letters, dispatches and cards that are delivered in the City of London; as a matter of fact, no letters or cards, but telegrams exclusively, are so dealt with. Neither is a fact that the City messages are exclusively transmitted by pneumatic tube, "Thousands of dispatches, letters and postal cards are literally shot by air pressure every hour of the day from the 20 postal tube stations located at the points most accessible into the Central Telegraph station. By the tube system no copying is done, the original message is delivered to the party to whom it is directed, unless it is to go by telegraph or telephone to points beyond London."

Who, we wonder, has been cramming Mr. Rosewater with statements like this? It is stated that "the Act of 1868 facilitated the collection and transmission of dispatches by designating places for depositing telegrams in letter boxes and other depositories, and telegrams deposited therein are, if written on stamped paper of proper value, conveyed by letter carriers to offices of transmission by wire or tube stations free of charge." Quite true, no doubt, as regards the Act, but no one appreciates these facilities, as they are very seldom, if ever, taken advantage or made use of; the "tedious formality" (as the author calls it) of handing in the message to the receiving clerk at the telegraph is practically the course always adopted, and not the reverse, as Mr. Rosewater imagines.

Here is another marvellous statement, referring to the Head Telegraph Office (T.S.) we are actually informed *nobody is permitted to receive by sound*. Query, has Mr. Rosewater really been over in England at all?

THE ELECTRIC LIGHT AT PORTSMOUTH.

SOME dissatisfaction has been caused at Portsmouth owing to the delay which has occurred in giving effect to the Borough of Portsmouth Electric Lighting Order, 1890. This, however, has been unavoidable, as after the council had adopted a low tension scheme it was deemed advisable to take further advice. Prof. William Garnett was consulted, and he has just submitted to the Electric Lighting Committee of the Town Council an estimate of capital and current expenditure and receipts for the lighting of the district specified in Schedule B., provisional order, and of the Southsea Esplanade, between the two piers. The estimate is based upon the assumption that, in accordance with the recommendations contained in a previous report, alternating currents, at a pressure of 2,000 volts, will be employed for the transmission of energy through the main leads. Prof. Garnett mentions that since his report was written a very complete series of tests has been carried out on the condensing turbo-generator by Prof. J. A. Ewing, F.R.S., Professor of Engineering in the University of Cambridge.* Prof. Ewing's results show that the turbo-generator is now as efficient as the best compound engine of the marine type, and that for light loads it stands unequalled, while in the first cost of the machine, and in the items of engine house and foundations, it enables a very considerable reduction to be made on capital expenditure. Prof. Garnett has therefore made his estimate, in the first instance, on the assumption that "turbo-electro generators" with surface condensers will be employed, and has made a supplementary estimate of the additional cost which would be involved if it should be thought desirable to employ condensing engines of the ordinary type, making not more than 90 revolutions per minute, coupled by endless rope gearing to dynamos making 300 revolutions per minute. Prof. Garnett has assumed that a site will be secured for the central station at which sufficiently clean sea water for surface condensers will be obtainable at all times of the tide within a distance of 250 yards. The grammar school has been selected as the point from which the lines of the high tension mains should diverge, and it has been assumed that the distance of the central station from this point will not exceed 500 yards. If it is impossible to fulfil this condition, the extra cost of mains will be at the rate of £2,700 per mile for the distance between the central station and the grammar school. Two concentric mains will be laid from the central station to the grammar school, each capable, if necessary, of carrying sufficient current for the whole of the lamps for which it is intended at present to provide. The two conductors, together, will serve all the requirements of the station until lamps have been installed equivalent to about 17,000 lamps of 16 candle-power. After describing the system of high tension mains, with both high and low tension conductors, which he proposes to adopt, Prof. Garnett states that, for the purpose of public lighting in the streets, instead of arc lamps, placed at distances of 50 yards or more, he prefers to employ "high efficiency" incandescent lamps of 150 candle-power, fixed at distances of about 80 yards. These lamps would be employed directly from the low tension conductors. They would need to be more frequently renewed than ordinary incandescent lamps, and this has been taken into account in the estimate of annual expenditure. 16 candle-power lamps should, except on the Esplanade, be carried in the same lantern with the 150 candle-power lamp, and should be switched on, in the place of the larger lamp, at 11 p.m., thus enabling the streets to be lighted all night at about the same cost, as to maintain the larger lamps until midnight. If incandescent lamps are adopted, only very light columns will be required for their support, and they will need no attention until they require renewal, while the present lamp columns will be used in most cases. Arc lamps require expensive standards, and cost about £4 each per annum for carbons and trimming, if burning until midnight only. As the conductors along the Clarence Esplanade (a portion of the sea front of Southsea) will be used for public lighting only, so that all the lamps connected with them will be switched on and off together, and as no small lamps are required in this situation during the whole night, it will be convenient to switch the whole of the lights on and off simultaneously by means of a high tension switch, at the point at which the Esplanade conductors branch from the mains near the Pier Hotel. On a public promenade the lighting up simultaneously of 90-power lamps will be effective. For the lights along the Clarence Esplanade arc lamps are less unsuitable than in the streets, but high power incandescent lamps would

* See next page.—EDS. ELEC. REV.

meet the requirements of the situation. The capital required for the installation of 8,800 private and 200 public lamps is estimated at £38,285. The cost of site is not included, as Prof. Garnett had not learned whether land, already the property of the corporation, would be available for the purpose. The receipts are estimated thus:—Private lighting, 352,000 units at 6d., £8,800; public lighting, 120,000 units at 4d., to include renewals of incandescent lamps, £2,000—total, £10,800. The expenditure, including interest on £40,000, to be borrowed at 3½ per cent., is put down at £7,572, leaving a balance of £3,228.

PARSONS STEAM TURBINE DYNAMO.

THE following is Prof. Ewing's report on trials of a 100-unit Parsons steam turbine dynamo, at Heaton Works, Newcastle-on-Tyne, December, 1891:—

The machine tested is, I am informed, the first condensing steam turbine that Mr. Parsons has built. Its shaft was designed to carry six small and one large plate or disc, each fitted with a series of rings of turbine blades, the large plate being specially designed to deal with low pressure steam. After passing it, the steam was exhausted into a jet condenser of novel design, the pump of which was driven by a separate donkey engine. The turbine rings were of the outward flow type.

The turbine was designed to work with steam at an initial pressure of 140 lbs. per square inch, but on the occasion of the trials it was not practicable, for want of a suitable boiler, to use a pressure of more than 95 lbs. per square inch. The first and second plates with their turbine blades were accordingly removed, and the tests were made with the remaining four small and one large plate. The effect of this was to make the results of the trials less favourable, as to economy in steam consumption, than they would have been had the full initial pressure of 140 lbs. been available.

In line with the turbine shaft, and directly coupled to it, was the armature of an alternate current dynamo capable of yielding 100 kilowatts, or 100 Board of Trade units of electrical energy per hour, and wound for a potential of 2,000 volts. The exciter was a distinct small dynamo of the continuous current Gramme type, which was also mounted on a prolongation of the turbine shaft.

The turbine ran at a speed of about 4,800 revolutions per minute, and the armature was wound with a single coil, so that the frequency of the alternations was about 80 complete periods per second.

The whole machine, comprising the turbine, dynamo, and exciter, weighed about four tons; its length was about 14 feet, and its greatest breadth barely 3 feet. It stood on three cast iron pedestals resting on an ordinary concrete floor. There were no holding-down bolts or special foundations, and none seemed to be required. The machine ran almost without vibration.

In the trials the current generated was spent on a bank of resistance coils, consisting of open spirals of iron wire strung on wooden frames. The output was varied, in successive trials, from about 20 units per hour, or say one-fifth load, to 100 units per hour or full load. The loads spoken of are the amounts of electrical power spent in the external circuit, and do not include the work done by the exciter in supplying current to the field magnets of the main dynamo. (The output of the exciter was about 2½ units per hour.)

In two additional trials there was no external load beyond what was necessary for measuring the potential.

The experiments were arranged to give complete information of the amount of steam used by the turbine under all grades of output, from full load to zero.

The electrical output was taken to be the product of the effective volts at the dynamo terminals into the effective ampères. The volts were measured by aid of a 2 H.P. transformer, which transformed down in the ratio of 1 to 10, and a pair of Cardew voltmeters. To test the accuracy of the professed ratio of transformation, the volts were on one occasion read by applying a Cardew voltmeter to successive portions of the bank of resistance coils (then grouped in series) so that the potential was directly determined by summing up the readings. This determination was found to agree exactly with that obtained by means of the transformer.

The Cardew voltmeters were themselves tested by comparison with a third Cardew, which in its turn had been standardised by help of one of Sir William Thomson's balances. They were found to be correct.

The current was measured by (1) an Evershed gravity ampèremeter, and (2) a Siemens electro-dynamometer. These were connected in series in several of the trials, and were found to be in perfect agreement. The Evershed instrument had been tested against a Thomson balance.

The consumption of steam in the turbine was measured by passing the feed water through a measuring tank, the capacity of which I checked. Steam was supplied from an old boiler of the locomotive type at a pressure of 90 to 95 lbs. per square inch. The steam pipe was too small, and the loss of pressure between the boiler and the turbine must have been considerable, especially in the full-power trials.

In the full power trials this boiler was insufficient to supply all the steam, and another boiler was joined to it. It was then impracticable to measure the feed, and the amount of steam passing through the turbine was estimated in these trials by measuring the rise in temperature of the water discharged from the condenser, in conjunction with the amount of the water, as gauged by means of a weir. This rise in temperature and the head over the weir were noted in all the trials, so that when the feed was directly measured, a constant was determined, which could be applied in cases where a direct measurement of the feed was impracticable.

The boiler was old and leaky, but the amount of water which fell to be deducted from the whole feed on this account was repeatedly determined. The allowances made for leakage are certainly not excessive, and do not in any case affect the full-power trials materially.

The steam required for (1) the feed pump, (2) the air pump, was supplied by a separate boiler, and is not included in the quantities that are stated below.

The vacuum ranged from 28½ inches, at light loads, to 26½ inches at full load. The temperature of the cold well varied from 5° C. to 18° C.

The trials extended over three days—December 12th, 14th and 15th, 1891. The turbine was kept running, without change of load, long enough in each case to secure a uniform *régime*, and to prevent any material error from being caused by an inexact reading of the water-gauge glass on the boiler. The machine ran without any hitch, throughout all the trials.

The following are the observed results. The trials distinguished by an asterisk are those in which the consumption of steam was inferred from the rise of temperature in the injection water. In the other trials it was measured directly, as feed-water.

Electrical output in units generated per hour.		Steam used in the turbine in lbs. per hour.	
0·3	.....	510	492 (mean)
0·3	.....	475	
20·8	.....	1,120	
31·2	.....	1,350	
48·5	.....	1,875	
65·9	.....	2,460*	
66·5	.....	2,580	
93	.....	3,530*	
100	.....	3,600*	

These results are also shown graphically in the accompanying curve, which shows the relation of the number of pounds of steam used by the turbine per hour to the number of electrical units generated per hour.

It is convenient also to express the results in another way, by stating the number of pounds of steam used per unit generated, at various rates of output from full load downwards. These quantities, obtained by measurement from the curve, are given in the following table:—

Output in units per hour.		Number of lbs. of steam used per unit.
10	.....	77½
20	.....	53
30	.....	45
40	.....	41
50	.....	39
60	.....	38
70	.....	37½
80	.....	37
90	.....	37
100	.....	37

It will be seen from these figures that the consumption of steam by this condensing turbine was 37 lbs. per electrical unit generated, when the machine was giving its greatest output; that the output might be reduced to, say, three fourths of its greatest value without causing any sensible addition in the consumption of steam per unit; and that at half load the consumption was 39 lbs. per unit. When the load is further reduced the consumption per unit increases, as it does in all engines, on account of the work which is expended within the machine itself.

The consumption of 37 lbs. per unit at full load corresponds to 27·6 lbs. per electrical horse-power per hour; and the consumption of 39 lbs. per unit at half load corresponds to 29 lbs. per electrical horse-power per hour.

For the sake of comparison it may be added that in a good ordinary compound condensing engine of corresponding power the consumption of steam is usually about 20 lbs. per *indicated* horse-power per hour, which corresponds (allowing for necessary loss in transmission to the dynamo) to say 36 lbs. per unit. In the special type of single-acting

high speed engines made by Mr. Willans and successfully used in many electric light stations the consumption of steam at full load and at moderately full load is somewhat less. The best results in trials published by him show (with high pressure and triple expansion) a consumption equivalent to about 30½ lbs. per unit in a non-condensing engine and 25 lbs. per unit in a condensing engine, worked at full load; while at half load the numbers are about 43 lbs. per unit and 32 lbs. per unit respectively.

I have no doubt that if it had been practicable in the turbine tests to use the full pressure of 140 lbs. per square inch, for which the turbine was designed (in place of a pressure of 95 lbs.) that the consumption of steam per unit would have been considerably reduced.

As they stand, however, the results must be admitted to demonstrate a very remarkable performance. They show that in respect of economy of steam, and therefore of fuel, at full or moderately full load the Parsons turbine of the type and size tested now challenges comparison with good engines of the usual kind, while its comparative freedom from friction gives it an exceptionally high efficiency when lightly loaded.

Apart from the question of steam economy, the lightness and compactness of the turbine dynamo, its small first cost, the perfect ease with which it is started, its freedom from vibration, and the absence of any need for heavy foundations, are points much in its favour as a generator for central station work.

Mr. Parsons has been good enough to give me every facility for examining the construction of his turbines and dynamos. I see no reason to anticipate that the charges for maintenance, for oil, and for attendance will be larger than in the case of other engines. I should rather expect them to be lighter; and this appears to be borne out by the experience of the Newcastle and District Electric Lighting Company, where turbine generators have been in use for about two years.

I had the advantage of seeing the plant at that company's station, and of obtaining particulars in regard to wages and other items of current outlay from the superintending engineer and the secretary of the company, who were most willing to supply information.

In regard to first cost, the turbine generator is probably cheaper, in large sizes, than any combination of ordinary engine and dynamo giving equal output. Mr. Parsons quoted to me the following prices for condensing turbines with dynamos, of either the alternating or continuous current type. The cost of the condensing plant is not included:—

50 unit	£600
100 unit	£850
200 unit	£1,300

The machine tested had an electrical governor which regulated by causing intermittent admission of steam. The action of this governor was not entirely satisfactory, and Mr. Parsons informed me that he meant to substitute for it a modified form of a type of governor which has been found to work well at the Newcastle and District Electric Light station and elsewhere.

The turbine worked at its full load of 100 electrical units per hour without any sign of distress, and, so far as could be judged, was capable of giving a greater output without difficulty. The dynamo armature became hotter than is, in my opinion, desirable. This might be avoided by an alteration in the winding of the armature.

With a dynamo wound to give continuous currents, the consumption of steam in the turbine per electrical unit generated may be confidently expected not to exceed the consumption observed in these experiments.

J. A. EWING.

Cambridge, *December 21st*, 1891.

THE HALLES MUNICIPAL ELECTRICAL STATION.

If we had still any doubt as to the error committed by the Municipal Council of Paris, the following statements—for the truth of which we can vouch—would be sufficient to prove that we must leave children to their mothers, and electrical enterprise to private industry.

The total power of the electrical station at the Halles is at present 384 kilowatts, 1,075 of which are used for public lighting.

We will now examine in succession the expenses at the works, and the receipts for the sale of the electric current during the first half-year of the season, 1891.

Expenses.		Fr.
Staff	...	45,931.80
Coal	881 tons. ...	34,947.80
Coke	1,268 tons. ...	47,152.80
Valvoline	4,526 kilos. ...	4,171.90
New oil	1,087 „ ...	919.25
Purified oil	284 „ ...	71.35
Grease	4,900 „ ...	4,253.35
Cotton waste	3,000 „ ...	870.30
Preparation for removing incrustation	410 „ ...	225.30
Removal of ashes ...	... ...	417.30
Maintenance of electrical plant	... ...	14,837.75
	Total ...	...Fr. 153,798.30

By doubling these figures we get for the whole year a total expenpenditure of 307,596.60 fr., and this approximate result should not differ greatly from the actual expenditure, as calculated from the items of which it is made up. We may, therefore, assume that the working expenses are not far off 315,000 francs per annum.

Receipts from the Sale of the Current.

Low tension system.	Kilowatt-hours.	Fr.
Central Halles	213,160 ...	131,343.30
Consumers	24,728 ...	37,087.45
High tension System.		
Consumers	17,067 ...	25,600.60
Belle Jardinière	81,583 ...	40,000
Totals ...	336,535 ...	254,031.35

Doubling these figures, we should get for the whole year 673,070 kilowatt-hours and 508,062.70 francs, figures which should be a little below the actual totals, for the consumption of light is greatest in the last quarter.

A priori there is between the receipts and expenses a difference in favour of the former of about 200,000 francs. This is what the administration considers as the profits, but we shall now see what must be taken off this.

In the budget of the municipal works, recently submitted to the Municipal Council, the situation was shown in a form that was as simple as it was attractive.

	Francs.
Receipts	611,000
Expenses	355,600
Apparent profits	255,400

In the receipts, the lighting of the Halles is put down at 395,000 kilowatt-hours, at 1 franc the kilowatt, whereas the city of Paris pays the electrical companies at the rate of 71 centimes the kilowatt-hour. There is, therefore, an over-estimate in the receipts of 144,550 francs.

Moreover, we must deduct from the expenses the sum of 9,500 francs, repayable by the consumers, and we must add to them the cost of rent, of water, and we must also take into account the interest and the redemption of the capital, dues and licenses.

These items may be estimated as follows:—

	Francs.
Expenses, as stated in budget...	355,600
Rent, 3,016 m. at 0·02 francs per day	22,023
Water, about	1,200
Interest and redemption, 7 per cent. altogether ...	79,100
Dues 5 per cent. on gross receipts	26,600
„ of 100 francs per kilometre of canalisation	500
Licenses	2,146
	487,169
Deduction of sum repayable by consumers... ...	9,600
Total expenditure...	477,569

If it were a matter of private enterprise, and not one for which the resources can be drawn from the municipal funds, the balance would be drawn up as follows:—

	Francs.
Receipts anticipated	478,450
Known expenses	477,569
Profits anticipated...	881

It must be confessed that for a capital at first of 1,130,000 francs, the profits are rather small. At present the cost price of the kilowatt is 48 centimes for the working expenses alone, and 80·5 centimes, if we include rent, redemption of capital, &c. Under these conditions, the electric lighting of the Belle Jardinière has been contracted for at 80,000 francs per annum, which is at the rate of 49 centimes the kilowatt, and means an annual loss to the city of 50,500 francs.

It may be worth while to give the mean price to consumers of the kilowatt-hour in the different sectors of Paris during the two years 1889-1890:—

Sector.	1889. Francs.	1890. Francs.
Edison	1·104	1·237
V. Popp	1·497	1·265
Place Clichy	1·499	1·368
Marcel Deprez	1·367	1·119
Municipal	—	1,100

For public lighting the price paid by the city of Paris is 71 centimes the kilowatt hour with arc lamps.—*Bulletin International de l'Electricité.*

Safety Fender for Electric Tramcars.—The Chester Manufacturing Company, of Boston, U.S.A., are introducing a new safety fender for electric tramcars, which was recently tested with satisfactory results. The fender consists of a triangular steel frame projecting from the front of the car on each side. The front of the fender is raised about 9 inches from the level of the road, so that it might pick up any obstacle which comes in its way.

ELECTRIC LIGHT

City, town, or district.	Name of company, if any.	Date of provisional order of licence.	The period at which the lighting commenced.	System of lighting used and names of makers of dynamos.	Power used.	Engines and boilers and their horse-power.	Total number of arc lamps now in use, C.P. and cost per hour.	Total number of incandescent lamps now in use, C.P. and cost per hour.	Number of arc lamps and incandescent used in street lighting.	Number of lamps added during the past 12 months.	The present arrangement for carrying out the lighting.
Bath	City of Bath Electric Lighting Co.	June, 1891	June 24th, 1890	Thomson-Houston for street lighting, Brush alternating for private lighting	Steam	Babcock-Wilcox boilers, Raworth's engines 600 H.P.	10 1,200-C.P.	4,000	84 arcs	1,200	Contract for seven years
Birmingham..	Birmingham Electric Supply Co., Ltd.	August, 1889	April, 1891	Low tension Crompton dynamos	Steam	Willans & Robinson steel Lancashire type	20 arcs, 1,500 C.P.	5,200 16-C.P.	.. ..	Supply only available since April 1891	Provisional order ..
Buckingham..	Buckingham Elec. Light Co. (private)	1889	1890	Low pressure and accumulators. Two Elwell-Parker dynamos	Steam and water	20 H.P. by water, 20 by steam	.. .. ..	3,004 16-C.P.	none	50	Licence
Chelmsford ..	Crompton & Co.	.. ..	May 14th, 1890	Alternating current and continuous arc lighting	Steam	Multi-boilers, Willans engines	.. .. ..	.. ..	20 arcs, 250 32-C.P. in., 950 glow-lamps pvte.	.. ..	Bd of Trade licence
Cowpen Quay & Waterloo, Blyth ..	Nicholson and Jennings	.. ..	.. ..	Brush dynamo	Steam	Babcock boiler, Statter engine	19 2,000-C.P.	Only nine in station	19 arc lamps	.. ..	Contract for five years
Eastbourne ..	Eastbourne Elec. Light Company	1890	Feb., 1892	Lowrie-Parker alternators and Lowrie-Hall transformers in parallel, transforming from 1800 to 100 in consumers' houses. Series circuit for arc lighting; Brush arc machines	Steam	Fowler & Co.'s engines and boilers, total engine H.P. 350	21 2,000-C.P.	6,000 10-C.P.	16 arc lamps	800	Licence
Exeter.. ..	Exeter Electric Light Co.	1891	September, 1889	High tension alternating (Brush). High tension series arc (Thomson-Houston)	Steam	Two compound horizontal non-condensing 120 H.P., each by Fowler; and two Westinghouse triple expansion of 25 H.P.	35 of 1,200 C.P.	3,200 8-C.P.	None	1,300 8-C.P.	Provisional order
Fareham ..	Fareham Electric Light Co.	.. ..	September 1st, 1890	Thomson-Houston	Steam	Ransome, Sims and Co. com. engine	21 1,200-C.P.	92 20-C.P.	.. ..	.. ..	Contract for three years
Galway	Galway Electric Co.	1890	June, 1889	Low tension. Crompton and Statter dynamos	Water Power	2100-H.P. Hercules turbines	2 2,000-C.P.	340 8-C.P., 2 500-C.P., 3 200-C.P., 3d. per hour	Two arcs	150 8-C.P.	Provisional order
Halifax ..	Halifax Mutual Electric Light & Power Supply Co., Ltd.	None	January, 1889	Low tension, two wire, 110 volts. Blakey, Emmott & Co.'s dynamos	Steam	Two Lancashire boilers, 150 I.H.P. each	80 2,000-C.P. (10d.)	400 16-C.P.	None	100 16-C.P., 10 arcs.	.. ..
Keswick ..	Keswick Electric Light Co.	No Provisional order	Sept. 1st, 1889	Alternate current transformers (Kapp 30 unit made by Johnson and Phillips)	Water	Turbines (Victor) 63 H.P.	1 300-C.P. 1s. per hour	730 17-C.P.	.. ..	.. ..	Contract
Leeds	Corporation	.. ..	Experiments first made in 1888	Incandescent on 3-wire system, and arcs in parallel, Mather and Platt dynamos	Steam for incandescent gas for arc	No. 4 Willans and Robinson 78 I.H.P. 400 revs., 2 multitubular boilers 160 H.P. each	10 2,000-C.P.	2,500	10 arcs, no incandescent	.. ..	.. ..
Liverpool ..	Liverpool Electric Supply Co.	1889 & 1891	1883	Direct current, 110 volts, Siemens and Crompton dynamos	Steam	Willans engines, Lancashire boilers 2,000 H.P. indicated	20 1,000-C.P. to 2,000 C.P. each	13,500 16-C.P.	None	2,000 16-C.P.	Provisional orders
London districts:											
Belgravia, including Pimlico	Westminster Electric Supply Corporation	August 26, 1890	March 2nd 1891	Generation at 200, and distribution in two parallels of 100 volts each. Battery in parallel with 200-volt dynamo, Crompton and Siemens dynamos	Steam	Willans and Davy Paxman engines, Davy Paxman "Economic" boilers and Fraser of same kind. Total I.H.P. 760 (not yet condensing)	.. .. ..	20,000 8-C.P.	None	20,000 8-C.P. since date of opening station in March 2nd, 1891.	Provisional order
Chelsea parish and a portion of Kensington parish ..	Chelsea Electricity Supply Co., Ltd.	Sept. 1886, for Chelsea; Aug. 1889, for Kensington	September, 1889	Low pressure and secondary batteries (E.P.S.) in sub-stations with continuous current motor transformers, constant pressure at feeding points. Elwell-Parker dynamo	Steam	7 Willans & Robinson G. G. engines 80 I.H.P., two Willans & Robinson H. H. engines 125 I.H.P. Babcock and Mill's boilers	Two	27,000 8-C.P.	None	8,000 8-C.P.	Provisional order
St. James's, Westminster	St. James's and Pall Mall Electric Light Co., Ltd.	License, 1888; provisional order 1890	April 4th, 1890	Three-wire continuous low-pressure currents from dynamos by Siemens Bros., and Latimer Clark, Muirhead	Steam	10 H. two G. G. Willans engines, 2,000 indicated H.P., six Davey Paxman loco boilers, 2,400 effective H.P.	About 50 scattered over the district	38,850 8-C.P.	40 of 50-C.P.	11,500 8-C.P.	Provisional order
Central Kensington and Knightsbridge	Kensington and Knightsbridge Electric Lighting Co., Ltd.	Licences & provisional orders obtained, 1887 and 1888	Jan., 1887	Low tension with secondary batteries, Siemens and Crompton & Co. dynamos	Steam	Willans engines 1,800 H.P., Babcock boilers 1,470 H.P., another boiler erecting	.. .. ..	38,000 8-C.P.	.. ..	14,000 8-C.P.	Provisional order
Kensington ..	House to House Electric Supply Co., Ltd.	1889	March, 1889	Alternating current transformer System. Lowrie-Hall	Steam	Compound horizontal engines and water tube boilers, about 700 H.P. total	.. .. ..	20,000 10-C.P., about 1s. 4d per hour	None	7,000 10-C.P.	Provisional order
St. Martin's-in-the Fields ..	Electricity Supply Corporation, Ltd.	.. ..	Oct. 29th, 1890	Direct current, low tension, 100 volts. Mather and Platt dynamos	Steam	Willans & Robinson 1,600 H.P.	10 2,000-C.P.	25,000 8-C.P.	None	15,000 8-C.P.	Provisional order

STATISTICS.

Present capacity in lamps of generating station.	Description of mains.	Length of mains now laid.	Cost of construction of central stations.	Percentage of the indicated engine power obtained at the terminals of the dynamo under conditions of normal work.	Coal consumption per hour for a unit, 1,000 watts delivered at dynamo terminals.	Price per unit.	Demand for electric lighting in the indicated district.	Cost of street lighting (if any) compared with gas.	Price of gas per 1,000 feet.	Name and address of engineer-in-chief.	Additional remarks.
30,000 incandescent, 200 arcs	Underground, Callender's solid system	40	£35,000	.. ..	10 lbs.	6d.	Limited	Double	2s. 8d.	M. C. Ollason	.. ..
10,000 16-C.P., ultimate capacity 25,000 lamps	Underground, Crompton culvert with copper strip for feeders; Callender's solid system for distributing mains	6,200 yards	.. ..	.. ..	.. ..	8d.	.. ..	.. ..	2s. 7d.	J. C. Vaudrey, M. I. E. E., 14, Dale End, Birmingham	.. ..
.. ..	Overhead	6 or 8 hundred yards	£1,200	No data	.. ..	25s. per lamp per annum	Very good, and increasing	.. ..	4s. 6d.	Rogers & Son	.. ..
2,000	Overhead	.. ..	£14,000	75 per cent.	8·8 lbs.	10d. to 6d.	Increasing	Same	3s. 9d.	A. H. Pott	.. ..
25 lamps of 2,000 C.P.	Overhead 7/16 cable	About 4 miles	£1,500	.. ..	.. ..	.. ..	.. ..	.. ..	3s. 9½d.	.. ..	This company does street lighting only
6,000 of 35 watts	Underground insulated cables drawn into cast iron pipes	9 miles	.. ..	70 per cent.	9 lbs.	10d. Public arcs £30 per annum, which includes carbons, trimming, and maintenance	Moderate	.. ..	3s. 2d.	H. W. Wilkinson. Central Station, Eastbourne Electric Light Company	.. ..
5,000 8-C.P.	Overhead wires, but contract is to be carried out by Fowler-Waring for underground	About 11 miles	Including outdoor mains, transforming, &c., £13,000	Over 85 per cent. at full load	.. ..	7½d., or by contract, 1s. per C.P.	Increasing	.. ..	3s. 1d.	T. P. Wilmshurst, Electric Light Station, Exeter	.. ..
.. ..	Overhead and underground	.. ..	.. ..	.. ..	.. ..	1s. per C.P. per annum.	Increasing	About the same	3s. 9d.	.. ..	.. ..
3,000 to 4,000 8-C.P.	Underground conduit	3,500 yards	.. ..	.. ..	.. ..	5d.	Good	.. ..	5s. 6d.	J. E. Pearce. Electric Lgt. Co., Galway	Water power (13 feet head) obtained from lake 15 by 20 miles
2,000 lamps of 8-C.P. At present fully loaded	Overhead wires	10 miles	.. ..	.. ..	.. ..	8d., or by contract	Good	.. ..	2s. 2d.	Managing director, W. Emmott	.. ..
.. ..	Overhead on Johnson and Phillips fluid insulators	.. ..	.. ..	.. ..	.. ..	1s. per C.P. per annum	Good	.. ..	4s.	W. R. Rice, engineer in charge	.. ..
.. ..	Underground lead covered leads in iron pipes	Streets round Town Hall	.. ..	No tests made. Usually running with light load, although variable	.. ..	Supplied only to Corporation buildings	.. ..	.. ..	..	.. ..	Yorkshire House-to-House Company will commence work this year.
15,000 16-C.P.	Underground Callender system.	40 miles	.. ..	.. ..	.. ..	Sliding scale, 12d. to 4d. per unit	.. ..	.. ..	3s.	A. Bromley Holmes	.. ..
30,000 8-C.P.	Underground copper in Kennedy type culverts. Insulated cable in Callender conduit	Total length of streets in which mains have been laid, 8·8 miles	.. ..	No data	7·8 lbs. of Welsh coal	8d. per Board of Trade unit	Have further applications amounting to 3,000 8-C.P.	.. ..	2s. 9d.*	Prof. A. B. W. Kennedy, F.R.S., M.I.C.E.	Efficiency of this station stated to be 91 per cent.
35,000 8-C.P.	Underground Callender - Webber bitumen concrete conduits and Callender's bitumen cable. Drawing-in system and feeding points	About 20 miles	.. ..	No data	.. ..	8d. per Board of Trade unit	.. ..	.. ..	2s. 9d.	H. Talbot, Draycott Pl., Chelsea.	.. ..
40,000 8-C.P.	Underground bare copper strip on porcelain insulators in iron culvert, armoured cable, iron pipes and vulcan. rubber services	7½ miles, including services and small cable runs	.. ..	Over 80 per cent.	Average of 7 lbs. throughout the year.	7d.	Increasing	.. ..	3s. 1d.	Sydney T. Dobson, A.M.I.C.E., of Mason's Yd., Duke Street, St. James's	.. ..
50,000 8-C.P.	Underground copper strip in culvert and Henley's cable in iron pipes, three wire and feeder systems	11 miles and 700 yards	.. ..	83 per cent. full load, 76 per cent. half. Mean 81 per cent.	Best in any one month, 6·5 lbs.	8d., with rebate to large consumers according to scale	Steadily increasing	.. ..	2s. 9d.	R. E. Crompton, Mansion House Buildings, E.C.	.. ..
25,000 8-C.P. lamps installed	Underground in cast iron pipes	21 miles	.. ..	No data	.. ..	8d., subject to discounts	Good	.. ..	..	Albert Gay	.. ..
45,000 8-C.P.	Underground Callender cables run in Callender bitumen casing	14 miles	.. ..	No data	.. ..	7½d.	Large demand	.. ..	2s. 9d.	H. A. Earle, Mather and Platt, 16, Victoria Street, S.W.	.. ..

* The price of gas is now increased in London.

ELECTRIC LIGHT

City, town, or district.	Name of company if any.	Date of provisional order of licence.	The period at which the lighting commenced.	System of lighting used and names of makers of dynamos.	Power used.	Engines and boilers and their horse-power.	Total number of arc lamps now in use, C.P. and cost per hour.	Total number of incandescent lamps now in use, C.P. and cost per hour.	Number of arc lamps and incandescent used in street lighting.	Number of lamps added during the past 12 months.	The present arrangement for carrying out the lighting.
Mayfair	Westminster Electric Supply Corporation, Limited	August 26, 1889	March 24th 1891	This station is still working on 2-wire system with batteries in parallel with dynamos, but is about to be changed over. Elwell-Parker and Crompton dynamos	Steam	Willans engines, Paxman "Economic" boilers, and similar boilers by Fraser, Total 1560 I.H.P., non-condensing	About six arcs	25,000 8-C.P., cost about 1s. 4d. per hour	None	25,000 8-C.P.	Provisional order
Notting Hill	Notting Hill Elec. Light Company	.. ..	May, 1891	Direct current Crompton's dynamos	Steam	Willans engines, Babcock & Wilcox boilers	.. .. ..	8,000 8-C.P.	.. ..	.. ..	Provisional order
St. Pancras ..	Electricity department of the Vestry	1888	Nov. 9th, 1891	Continuous current 110 volts. 3-wire system, Kapp's multipolar dynamos	Steam	Willans triple expansion engines, Babcock & Wilcox boilers	Connections increasing daily	Increasing daily	26 arcs being erected	.. ..	Provisional order
Westminster	Westminster Electric Supply Corporation, Limited	Aug. 26th, 1889	Nov. 11th, 1890	Generation at 200 volts and distribution in two parallels of 100 volts. each; batteries in parallel with 200-volt dynamos, Goolden, and Mather and Platt	Steam	Willans engines, Babcock boilers, total I.H.P. of engines 1,120 (not yet condensing)	About a dozen arcs	14,000 8-C.P.	None	14,000	Provisional order
Newcastle ..	Newcastle and District Electric Lighting Co., Ltd.	.. ..	.. ..	Alternate current transformers	Steam	.. .. ..	.. .. ..	10,500	.. ..	.. ..	Licence
Northampton	Northampton Elec. Light and Power Co., Ltd.	1890	March, 1891	Direct current low tension. Crompton dynamos	Steam	Two Scott & Hodgson's compound engines, 120 I.H.P. each; two Daniel Adamson Lancashire boilers, 120 lbs. steam	6 from 6,000 to 1,000 C.P.	3,250 8-C.P. cost per C.P. hour = ·0314d.	7 100-C.P.	3,250	Provisional order
Preston	National Elec. Supply Co., Ld., Preston	.. ..	Jan., 1891	2-wire low tension system, Blakey Emmott dynamos	Steam	One Marshall 40 N.H.P. portable engine, one Robey 16 N.H.P. semi-portable engine	8 1,000-C.P., 8 1,000-C.P.	1,921 8-C.P.	60 incandescent	New this year	Temporary installation to ascertain the feeling of the district
Reading ..	Laing, Wharton and Down Syndicate	.. ..	March, 1889	Thomson-Houston	Steam	Two Browet-Lindley 25 H.P. and Westinghouse, one at 50 H.P., one at 25 H.P.	64 arcs	600 8-C.P.	None	.. ..	Agreement with Corporation
Southampton	Southampton Elec. Light Company	1890	May, 1891	Low tension with batteries, Crompton dynams	Steam	Two Marshall boilers, 20 and 40 N.H.P.; one Robey 40 N.H.P. engine	47 arcs	900 8-C.P.	None	.. ..	Licence
Taunton ..	Taunton Elec. Light Co.	.. ..	1886	Thomson-Houston	Steam	.. .. ..	31 arcs	400	.. ..	.. ..	.. ..
Weybridge ..	Weybridge Elec. Light Company	June, 1891	March, 1890	Thomson-Houston system	Steam	Two 75 H.P. compound engines; one 100 H.P. boiler	.. .. ..	500 16-C.P.	120 16-C.P.	3,505 16-C.P.	Provisional order
Waterford ..	Weybridge Elec. Light Company	.. ..	Sept., 1887	Thomson-Houston system, four T.-H. arc dynamos, and two T.-H. composite field alternators	Steam	120 H.P. Fowler (horizontal), 120 Marshall, two loco boilers	34 1,200-C.P.	None	34 1,200-C.P., back streets lighted by oil	.. ..	Contract
Chagford ..	G. H. Reed	.. ..	Sept. 1st, 1891	Alternating transformer (Hedgehog) Siemens Bros. dynamos	Water	.. .. ..	.. .. ..	300 8-C.P.	20 32-C.P.	.. ..	Contract

BUSINESS NOTICES, &c.

The General Electric Power and Traction Company, Limited.—It will be gathered from the directors' report, which was published on December 18th, that electric traction has been almost entirely stopped by legislative and local obstacles of so stringent a character, as to practically prohibit business. In spite of this, however, considerable progress has been made. The service of electric cars at Barking has been improved, and advantage has been taken of the experience there gained in estimating for maintenance contracts on a large and commercial scale. Indeed, as was foreshadowed by the chairman's speech to the shareholders, the company have reason to expect traction orders to the extent of £150,000 during the coming year. With the knowledge they have gained, there is but little doubt of a satisfactory result. The sub-contract with the E.P.S. Company for the maintenance of the accumulators at a fixed mileage rate removes the only doubt which capitalists may have had for the success of this form of electric traction; for it is needless to say that the combined companies, with their unrivalled opportunities of gaining experience, are quite capable of carrying out contracts entrusted to them. Apart from Barking, considerable progress has been made in other places. For some months a self-contained car was run over the tramway system at Liverpool carrying ordinary loads, and keeping schedule time, thus proving the practicability of this class of car over steep grades. A smaller accumulator car is now being built for use on the Birmingham lines, so as to make comparison with the cost of the large double bogie trams running there at present. It is finally believed by the company that these small accumulator cars, carrying about 36 passengers, will satisfactorily solve the problem of tramcar propulsion in our crowded thoroughfares. In mining work the company has been very busy, and has fully doubled the quantity of work done in this department in the preceding year. Electricity has been used for lighting, pumping, hauling, fan driving and coal getting with unvarying success. In launch work, the company stands practically alone, and during the busy periods of last season, controlled the pleasure traffic of the Thames. Towards the week's end the whole of their available boats were usually let, and in some cases could have been let two or three times over. In spite of the bad season, this department has been a distinct success, and should the weather be at all favourable next year, a very handsome dividend may be evidently looked forward to from this department. Viewing the rapid extension of launch work, the company have acquired land near Chertsey, and are now building hulls for their clients and for

STATISTICS—*Continued.*

Present capacity in lamps of generating station.	Description of mains.	Length of mains now laid.	Cost of construction of central stations.	Percentage of the indicated engine power obtained at the terminals of the dynamo under conditions of normal work.	Coal consumption per hour for a unit, 1,000 watts delivered at dynamo terminals.	Price per unit.	Demand for electric lighting in the indicated district.	Cost of street lighting (if any) compared with gas.	Price of gas per 1,000 feet.	Name and address of engineer-in-chief.	Additional remarks.
62,500 8-C.P.	Underground copper in Kennedy type culvert. Insulated cable in Callender conduits	Total length of streets in which mains have been laid, 9·5 miles	.. ..	No data	6·6 lbs. Welsh coal	8d.	Applications already signed for an additional 5,000 lamps	.. ..	2s. 9d.	Prof. Kennedy	.. ..
10,000	Underground, three-wire system	6 miles	£17,000	75 per cent.	9 lbs.	8d.	Good	.. ..	3s. 1d.	George Schulz, Central Station, Bulmer Place. W.	.. ..
10,000 16-C.P., 90 arcs	Underground culvert. Bar copper strip on insulator	5½ miles	£60,000, including mains	No data	.. ..	6d.	Up to December, 1891, contracts had been signed for nearly the whole of the output	.. ..	2s. 9d.	J. T. Baron, M.I.E.E., Vestry Hall, St. Pancras	.. ..
45 000 8-C.P.	Underground. Copper in Crompton culverts and insulated cable in pipes and casing	Total length of streets in which mains are laid, 4·8 miles	.. ..	No data	6·90 lbs. of Welsh coal	8d.	Further applications signed for 1,500 lamps	.. ..	2s. 9d.	Prof. A. B. W. Kennedy	Average efficiency of the three stations (ratio of current generated to current paid for) for the last six months has been 86 per cent., but it is now rising as the two-wire is changed into the three-wire system
Ultimate capacity will be 50 000	Underground	.. ..	.. ..	.. ..	.. ..	£d.	.. ..	.. ..	1s. 9½d.	W. O. Hunter	.. ..
9,900 8-C.P., will soon be 6,000 lamps	Crompton's underground mains	3,000 yards	£7,000	No data	No data	9d. a unit, subject to discount	Rapidly increasing	.. ..	2s. 4d.	B. R. Beale, Angel Lane, Northampton	.. ..
Station working to utmost capacity	Overhead	3 miles	Question objected to	Not tested	.. ..	8d.	Large, unable to execute orders	.. ..	3s. 3½d.	F. F. Bennett, Laurel Villas, Ashton-on-Ribble, Preston	New station being erected with a capacity of 50,000 8-C.P.
Plant fully loaded	Overhead	4½ miles	.. ..	No data	.. ..	Arc by contract. Incandescent by meter	Considerable	.. ..	3s.	F. F. Yeatman, The Island, Reading	.. ..
1,500 8-C.P.	Underground Crompton system	1 mile	.. ..	No data	.. ..	10d., with rebate	Considerable	.. ..	3s.	J. S. W. Aldridge, 23, High Street, Southampton	Station not Complete
3,000 8-C.P.	Overhead	.. ..	.. ..	.. ..	.. ..	.. ..	Great demand	.. ..	4s.	H. E. Hunt	.. ..
2,500	Overhead	7 miles	.. ..	.. ..	9 lbs.	9d.	Good	.. ..	4s. 6d.	Percy Mossop, Weybridge Elec. Works.	.. ..
Working at full capacity	Overhead	.. ..	.. ..	No data	.. ..	.. ..	.. ..	.. ..	4s. 6d.	P. Peters, Elec. Light Depot, Waterford	.. ..
.. ..	Underground, lead covered paraffin paper insulation	1,800 yds.	£2,000	.. ..	.. ..	£1 per year, 16 C.P.	A growing demand	.. ..	6s. 8d.	George Reed, The Factory, Chagford	.. ..

future extensions of the Thames fleet. During the Naval Exhibition a special feature was made of this branch of the company's business, and an electric pinnace of the man-of-war type was shown, equipped ready for slinging in davits. This led to some important business with foreign governments, and three sea-going boats, 50 feet in length, were despatched to Russia. On Lake Windermere the company's launches were usefully employed during the whole of the season, and derived their power for charging solely from a turbine, the first instance of the kind known when water-power was used for charging boat accumulators. Arrangements have been concluded with the Manchester Ship Canal Syndicate, by which a fleet of electric launches will run on part of the Ship Canal early in the spring. The company are about to erect an extensive electric copper refining plant on the bank of the Thames, which they hope to have in full operation about April next. The company have given considerable attention to electric lighting in both London and the provinces, and have had a very satisfactory amount of work for this department. The sale of dynamos and motors for general purposes has largely increased, and the company are confidently looking forward to a further extension of the motor trade, with both direct and alternating current, as the use of electricity from central stations becomes more largely adopted.

Electric Lighting in Ireland.—Mr. MacCarthy, of Antrim, Ireland, has carried out the following installations during the last four months: An installation at the new offices at Messrs. Workman, Clark & Company's shipyard at Belfast, consisting of a Taunton 100-light dynamo, driven by a 4 H.P. Hindley horizontal engine. The main wires are carried overhead to the offices, a distance of 150 yards. The same firm have their new engine and boiler works also lit throughout by 75 200-C.P. sunbeam lamps and 150 16-C.P. lamps, the dynamo being of the Taunton make, and giving an output of 48,000 watts at 200 volts pressure; this machine is also driven by a large Hindley steam engine. As will be seen, the dynamo is capable of lighting a far greater number of lamps, which will be added as required; these lights are to be placed over the different machines, and as a good deal of the machinery is not yet in place, the positions of the lights cannot be definitely fixed upon. This installation is run in rather a unique manner, in order to avoid the variation in volts which would occur when some of the lights are turned off at the distant end. The frontage of the buildings being 840 feet, and the dynamo situated at the end furthest away from the largest proportion of lights, it was thought necessary to run the lamps in engine works in five different groups, each group having separate cables to the machine, the switches being placed at the lamp

end of the wires, and not, as usual, at the dynamo. Messrs. William Ewart and Sons, Belfast, are also having another of their mills fitted up with a 500-light installation, which when completed will be one of the finest mill installations in the country, as no expense has been spared in the fittings used throughout, which are all of the very latest type. Messrs. Spence, Bryson & Co., of Portadown, have recently built a new weaving factory, and have had the electric light installed; the dynamo is of Taunton make, and gives an output of 16,500 watts with an E.M.F. of 100 volts and a speed of 800 revolutions. Mr. J. Boal is just now completing a new weaving factory in Antrim, which is also to be lit by electricity; the dynamo, of Taunton make, driven by a Hercules turbine, the output of the machine to be 16,800 watts at a speed of 800 revolutions. Messrs. J. H. & G. Bellis have also added 90 lights to their extensive installation. They were the pioneers in electric lighting in the North of Ireland, theirs being the first linen weaving factory to adopt the light, which has now been running for over three years without the smallest hitch. All the above installations have been carried out—or have been nearly completed—within the last four months by Mr. C. C. MacCarthy, of Antrim and Belfast.

Messrs. Drake and Gorham.—Although in the early part of the year the business was naturally affected by the serious accident to the senior partner, the turnover soon recovered, and the record for the year shows a total of over 50 installations executed, being at the rate of nearly one per week. Amongst these may be mentioned:—Margam Abbey, Port Talbot, worked by a combination of steam and water power, which supplies 400 lights; Wynyard Park, for the Marquis of Londonderry, steam plant, 1,000 lights; Rhinefield, for Lieut. Munro, steam plant, 550 lights; Leonardslee, Horsham, for Sir E. G. Loder, 110 lights; Felstead Schools, 450 lights; Hoddam Castle, Ecclefechan, gas engine plant, 150 lights; Shendish, for Mr. Longman, gas engine plant, 110 lights; Swyncombe, for Mr. Emil Reiss, steam engine plant, 150 lights; Ardoe, for Mr. Ogston, petroleum engine plant, 100 lights; Adhurst St. Mary, for Mr. Bonham Carter, petroleum engine plant, 200 lights; The Lodge, for Mr. De La Rue, 150 lights; Clatford Mills, for Mr. Forster, water power, 100 lights; and a number of other country residences. The electric light has also been fitted for use at the St. George's Hospital and Westminster Hospital, and special apparatus designed for the application of electricity to surgical operations. A large number of houses have been fitted up for an outside supply, including the Duke of Northumberland's London residence, Lady Cummins's, and many others. The Cardew patents held by the firm have been further developed, and the Cardew voltmeter continues to hold its own amongst the host of cheaper rivals, and the earthing device has been formally approved and sealed by the Board of Trade. The D.P. battery has been further developed, and a large number has been supplied to the trade and private houses with the most gratifying results.

Browett, Lindley and Company, Limited.—This firm report that during the past year their works have been fully employed in the construction of engines for electric lighting as well as for other purposes, among the large number of small engines being an increased proportion of direct coupled high speed engines for ship lighting, of which, alone, some 50 sets have been turned out during last year, and at the present time they start the year with a fair number of recent orders unfinished, including some engines for the Manchester Corporation, and a 150 H.P. vertical compound surface condensing engine for extension of the lighting of Woolwich Arsenal. Among the land installations for which they have built the engines are several collieries and large warehouses, in addition to a 75 H.P. engine for lighting the new extension of Lloyds House, Manchester, the earlier installation being also engined by them some five years since. They are also building the engines for the Manchester Edison Company for lighting the immense sanatorium recently built at Eccles by the Salford Corporation. As their present works have been far too small for some time, they have just erected modern works at Patricroft, near Manchester, near the Barton Swing Aqueduct of the Manchester Ship Canal, and request us to state that in a few weeks these works will be in operation. The firm are exhibiting at the Crystal Palace, stand 51 and 52, where some of their engines will be in motion coupled to dynamos.

Swinburne and Company.—This firm reports that their business in transformers has largely increased during the past year. They find the demand for their type of transformer gradually growing, both at home and abroad. During the year they have also brought out alternating current condensers, as many engineers thought the exciting currents of their transformers would give trouble. Except with station engineers, who still think an idle current means power, the trouble has never come up in practice, but there has been some demand for condensers, as there is a great deal of experimental work on motors and other apparatus involving them. They have also brought out alternating current gear for testing cables under high pressures. They are now making a plant to give 40,000 volts and 3 ampères, for the Silvertown Company, who wish to test cables by the mile under high pressures. Messrs. Swinburne & Co. are now bringing out specialities in instruments for central station work. Their wattmeter, for transformer testing has been already described in this journal. Messrs. Swinburne and Co. attribute much of their increased transformer business to a new departure in the way of keeping a large stock of transformers ready to send out. The advantages of this course weigh more than scientific high efficiencies.

J. K. Fahie and Son.—Messrs. J. K. Fahie and Son, electrical engineers, of Dublin, have been fairly busy during the year, especially in the capacity of consulting electrical engineers. Numerous inspections of suitable water power in the country districts for driving dynamos have been made, and various reports prepared. The firm have now under their superintendence several installations, the most important carried out during the year being that of the suburban residence of the well-known southern brewer, J. J. Murphy, Esq., J.P., on the banks of the Lee. The firm expect to have a good share of electrical work on hand during the present year.

Civilised Turkey.—The Imperial Ottoman Bank are building large premises at Constantinople, and lately instructed their architect to get tenders from a few of the leading English firms for the supply of 300 lamps with generating plant complete. The contract for the work was given to Messrs. Drake and Gorham on account of the large experience they have had in English office and bank lighting, but shortly afterwards information was received that the Sultan had insisted upon the order being cancelled. Report says that it was represented to His Majesty that the dynamite used to generate the current might cause an explosion at any time. No official confirmation has been received as to this explanation, but the fact remains that gas has to be put throughout the bank as the royal permission cannot be obtained.

Catalogues Wanted.—Mr. C. Purcell Taylor, D.Sc., of 57, Chancery Lane, asks, on behalf of a Foreign Government, for catalogues and other illustrated matter of instruments and machinery for telegraphs (land and submarine); telephones; lighting by all systems; obtaining power from waterfalls; in the chemical applications of electricity to tanning and similar purposes. Catalogues in English or French languages preferred.

The "Crown" Electric Light Company.—The "Crown" arc lamp, illustrated and described in our last week's issue, may be seen, and every information regarding it obtained on application to the "Crown" Electric Light Company, 80, Queen Victoria Street, London, E.C.

Change of Address.—Mr. J. E. B. Pritchett announces that he has taken his brother, Mr. T. W. Pritchett, late of the Metropolitan Electric Supply Company, into partnership, and that in future the business will be carried on at 1, Hanway Place, Oxford Street, W., under the title of "Pritchett Brothers."

The Electric Light in South London.—Electric lighting in South London is being rapidly extended. The latest establishment to be fitted with it is the Surrey Theatre and the adjoining premises. The work is being carried out by the Planet Electrical Engineering Company, of 4, Victoria Mansions, S.W.

Tenders Wanted—Durban.—The corporation of the town of Durban are asking for tenders for the supply of electric lighting to the inhabitants, who number about 24,000, and for the lighting of the public streets.

Charlesworth, Hall and Company.—Messrs. Appleton, Burbey and Williamson, of 92, Queen Victoria Street, London, E.C., have been appointed London agents for Messrs. Charlesworth, Hall and Co.

Catalogue.—We have received from Roper's Electrical Engineering Company, Limited, of Bradford, a copy of their January, 1892, price list of dynamos, motors, electric mining, pumping and hauling machinery; also patent short arc lamps and accumulators.

Almanacs, &c.—We have received the season's greetings from the Commercial Cable Company, with an illustration of their repairing steamer, *Mackay-Bennett*.

"Discovery."—We have received a copy of No. 1 of Volume 2 of the new series of this journal, which is published weekly. It is well illustrated, and contains a large amount of information.

NOTES.

The Electric Light in Hungary.—It is said that the town of Warasdin in Hungary is to have an electric lighting station.

Frankfort Exhibition Surplus.—The surplus after paying all expenses amounts to £7,600. Out of this sum the town of Frankfort and the local Chamber of Commerce will receive back their guarantees, whilst to the exhibitors will be returned a large amount of the costs for space and power.

The Electrical Utilisation of Water Power in Ireland.—A movement is at present on foot with respect to the electrical utilisation of the abundant water power of Ireland, and it is expected that the water power of the Liffey will soon be used for lighting a portion of the city of Dublin.

Electric Traction in Lyons.—It is stated that the Lyons Tramway and Railway Company are studying a system of electric traction in which they have great hopes of its being made commercially successful. The contractors will not only guarantee a regular service of cars, but will also undertake that such an economy will result from the adoption of the system as will considerably diminish the working expenses.

The Bressia Prize.—The Imperial Academy of Science of Turin has awarded the Bressia prize of 12,000 francs to Prof. Hertz, of Bonn.

The Port-Electric System.—A company has just been formed in West Virginia called the United States Port-Electric Company with a capital of £1,000,000. The company has been formed to take up the electric system of transporting letters and small parcels at a high rate of speed. It will be remembered that an experimental line on this system, which was described by us, was erected and tried at Dorchester, Mass., U.S.A., a short time ago.

The Electric Light at Coventry.—The works of the Coventry Gas Fittings Company in Hertford Street, Coventry, have just been fitted with the electric light. The work has been carried out by Messrs. Verity and Sons.

Electric Railway in Dresden.—A limited company is being formed to build an electric railway from the Pionier barracks in Neustadt to Pillnitz, the summer residence of King Albert. The power station is to be erected at Striesen and the various localities through which the line will pass will be lighted electrically. The railway, which is estimated to cost £75,000, is to be constructed by Messrs. Schückert and Company of Nürnberg, and the King is said to take great interest in the project.

The Parsons Steam Turbine Dynamo.—Judging from Prof. Ewing's report on this apparatus, and bearing in mind that Prof. Garnett had previously spoken very highly of it, there appears to be no reason to doubt that it will soon be in considerable demand for electric lighting stations. The small loss from friction when running on light loads is much in its favour.

New Books.—Messrs. Whittaker and Company have made arrangements with the editor of *El Telegrafista Espanol* for the translation into Spanish of Mr. Preece's work upon "The Telephone"; the book already has been translated into both French and German. The same firm will publish shortly in a cheap form, Mr. A. R. Bennett's papers "On the Telephoning of Great Cities" and "The Electrical Parcel Exchange System, which attracted considerable attention at this years' B.A. meeting. But why not append the many criticisms upon Mr. Bennett's telephonic scheme which appeared in the ELECTRICAL REVIEW?

How is it Spelt?—Some years ago we drew attention to the various ways in which the name of the inventor of a well-known form of semi-dry Daniell battery have been spelt. We mentioned "Menotti," "Minotti," "Menotto"; now we have one more variation, viz., "Minnotti," this being the spelling given by the writer of an excellent series of practical notes on galvanometers which are appearing in our American namesake. Once more we state that the correct spelling (on the authority of the Chief of the Italian Telegraph Administration) is "Minotto," neither more nor less.

Obituary.—Old telegraphists in South Wales and the West of England will be sorry to learn of the death of Mr. I. Clarke, which took place in Manchester, shortly before Christmas. Mr. Clarke had been engineer to the Lancashire and Cheshire Telephonic Exchange Company from its commencement, and retired from ill-health shortly before the amalgamation with the National Telephone Company.

Mr. Richard F. Leyland, president of the National Telephone Company, died suddenly in the train last Monday afternoon, on the Underground Railway, London, between the Mansion House and Blackfriars Stations. He was head of the well-known Liverpool firm who owned the Leyland line of steamers. The deceased, who was in his sixty-first year, had a remarkable successful career, having risen from an office boy. The Leyland flag is now known in many parts of the globe.

Westinghouse Electric Company.—According to the *Financial News*, people close to the management of the Westinghouse Electric Company say that the contracts at present on hand aggregate over $1,000,000, and that the business is steadily growing.

Protection of Underground Electric Wires.—The Johnstone patents for the protection and preservation of electric wires underground have been acquired by an English syndicate, and will, says the *Financial News*, be brought before the public shortly.

Fatal Electric Wire Accident in America.—A plumber, who was engaged in making repairs at the Birmingham Company's power house, Birmingham, Pa., was killed by a live wire the other day. With a fellow workman he mounted a ladder to make a connection near the ceiling. His companion held the pipe, and Sullivan began to drive a nail into the wall to hold it. In striking at the nail he missed it and struck a live wire. An awful flash resulted. Sullivan fell backward, striking another live wire with the back of his neck. He was thrown into the air, and then fell to the floor, dead.

Electric Lighting at Bath.—At a recent meeting of the Bath Surveying Committee a letter was read from the Watch Committee calling attention to the defective lighting of the city by electricity. Serious complaints had been made as to the fluctuating character of the light, and to the frequency of the lamps being out altogether. It was decided that the Electric Light Committee should report on the matter at the next meeting, with special reference to a prevention of the defects in future.

Fatal Electric Lighting Accident at an Italian Theatre.—A Naples correspondent of the *Daily News* states that a fatal electric lighting accident occurred on Saturday night at the Theatre Mangano at Palermo. One of the men inadvertently took hold of both connecting wires, and fell dead.

The Electric Lighting of Cannes.—We hear that the new electric lighting is giving the greatest satisfaction. All the principal hotels have ordered the illuminant, which is to be supplied to them by the Société de Lumière Electrique.

Electric Lighting in St. Pancras.—The St. Pancras Vestry have deposited a Bill, which will be introduced into Parliament next session, under which powers are sought to raise £360,000 for the electric lighting of the whole of the parish, in addition to any sum that may be required for paying the costs of obtaining this Act. The period for the redemption of the loan is fixed at 42 years. The vestry also seek power by this Bill to appropriate for electric lighting purposes the pneumatic tubes laid by the Pneumatic Despatch Company, but now abandoned, in Tottenham Court Road, Euston Road, Hampstead Road, and Drummond Street.

Electric Lighting of Glasgow.—It is generally believed that Glasgow Town Council will, at its next meeting, formally approve of the purchase of Messrs. Muir, Mavor, and Coulson's central electric lighting stations, and of their whole undertaking, on the recommendation of the Corporation Electric Lighting Committee.

Belgian Government and Telephones.—The Belgian Government has informed the Belgian Telephone Company of its intention to resume from January 1st, 1893, the working of all the telephone lines in Belgium.

Personal.—We are glad to see that the Queen has been pleased to confer a title, amongst others, upon Sir William Thomson. According to the *Times*, it is probable, though not yet decided, that the title which he will take will be that of Lord Kelvin, from the name of the beautiful river which flows past the foot of the College grounds at Glasgow, and on which his windows look out. But electricians generally would have preferred that, like Lord Tennyson, he had retained his own name.

Shipbuilding by Electric Light.—For some years past, says the *Western Morning News*, the electric light has been utilised at Portsmouth Dockyard to facilitate shipbuilding, whilst at Chatham the system was tried and abandoned, owing, it is stated, to the expense. At Devonport the ships have hitherto been built and repaired by candle light, but within the last few weeks very complete arrangements have been carried out for lighting the interiors of the vessels under construction by electricity.

Crystal Palace Electrical Exhibition.—One of the most interesting features of this exhibition, showing the development of telephone enterprise, will be the concert room of the National Telephone Company, where on payment of a small fee the public will have the opportunity of listening to the music which is being performed at theatres in London, Birmingham, Manchester, and Liverpool.

City and Guilds of London Institute.—On January 20th, 1892, Mr. A. Reckenzaun begins a course of six lectures on "Electric Locomotion," dealing with electric tramways and railways. These will be given on Wednesdays at half-past seven. Through the spring, also on Wednesdays, will be held Mr. Rousseau's practical classes in the new electro-plating laboratory, in connection with which Prof. Thompson will give three special lectures, on dates to be announced. On February 9th and succeeding Tuesdays, Mr. W. C. Clinton will give a short course on Vector methods of calculation in relation to electrical problems, being an introduction to the writings of Mr. Oliver Heaviside. Prof. Perry is continuing his course on the applications of the differential and integral calculus, and will conclude by an exposition of Fourier's theorem in relation to alternate currents and the use of the electrodynamometer in harmonic analysis. Prof. Silvanus Thompson continues his ordinary course of Monday lectures, the topics until Easter being transformers, alternate-current motors, and the design of continuous current dynamos.

Electrical Massage.—The short paper by Mr. Nikola Tesla, which we publish this week, will create much interest in medical circles, and we may soon expect to hear that the idea has been turned to account by unqualified medical electricians, who will thus be enabled to lay yet another trap for the easily imposed upon public.

Chicago Exhibition, 1893.—The first meeting of the Fine Arts Committee was held on Monday last at the Society of Arts.

Manchester Electric Lighting.—At the monthly meeting of the Manchester City Council, held on Wednesday last, it was resolved that, on the recommendation of the Electric Light and Hydraulic Power Joint Sub-Committee, and having regard to the probabilities of extension and the future developments of both electric light and hydraulic power, the committee approve of the site in Dickenson Street being allotted entirely to electric lighting, and that in Gloucester Street to hydraulic power, as there was not sufficient space in the Dickinson Street yard for both purposes.

Tenders for Lighting Christiania.—The following is a list, extracted from a Norwegian paper, of the tenders for the supply and erection of plant for the Christiania Electric Lighting Station :—

O. L. Kummer & Co., Dresden	£38,000
Schuckert & Co., Nurnberg	39,640
Woodhouse and Rawson...	39,780
Actiengesellschaft fur Cromaccumulatoren, Berlin	41,380
Thomson-Houston, Hamburg	42,340
Siemens and Halske, Berlin	42,670
Helios, Cologne	42,810
Sharp and Kent	44,600
Siemens Brothers	44,670
Compagnie Continentale-Paris	45,040
Crompton & Co.	47,340
Electric Construction Corporation	47,480
Edison General Electric, New York	57,130

The tender of Schuckert & Co. was accepted.

Preston.—The staff of the National Electric Supply Company, Limited, and a few friends, held their first annual supper at the mess rooms, Preston, on New Year's Eve, to celebrate one year's work of the electric lighting of Preston. The chair was taken by F. F. Bennett, Esq., M.I.E.E., supported by the committee, consisting of S. F. Emerson, T. Cross, S. Powell, and C. Gillin.

The Institution of Electrical Engineers.—The first meeting of the current year will take place on Thursday, the 14th inst., when the President, Prof. W. E. Ayrton, F.R.S., will deliver his inaugural address.

A Protest.—We have received a number of letters expressing emphatic approval of the protest which we made last week in the interests of the Crystal Palace Electrical Exhibitors. What we considered as our duty being now accomplished, the matter should be brought before the Committee of Advice.

Storms and Telegraph Wires in Berlin.—A terrible storm, like an American blizzard, set in at Berlin on Tuesday night. Great havoc among the telegraph and telephone wires ensued.

Electric Thermometers.—An electric thermometer is at present in course of erection at an orange grove at Tahiti, Flo., U.S.A., by the Nassau Battery Company of New York, by means of which the superintendent of the grove can be notified in his house, 800 feet distant, whenever the temperature in the hothouses falls to 40 degrees.

The Electric Light in German Vessels. — The Oesterreichische Nordwest Dampfschiffahrts-Gesellschaft have just completed at their Dresden yards what is said to be the largest cargo steamer ever put in service on the Upper Elbe. The vessel, which is intended for service between Hamburg and Magdeburg, is 213 feet long, has triple expansion engines of 750 H.P. and 3 feet 6 inches draught, and is fitted throughout with the electric light.

Church Lighting.—It is stated that the church of St. Mary-le-Strand is now lighted with the electric light.

Coal Consumption.—Notwithstanding the great increase of the electric light in London and other large towns, it is observed that during the year 1890 the gas companies of the United Kingdom accounted for increased consumption, according to Board of Trade returns, of 570,000 tons. This is said to be the largest increased consumption for the last ten years. The general manager of one of the largest gas companies in London, being alarmed at the great increase of the electric light in his district, took out for his own satisfaction the consumption in one area where the electric light was chiefly consumed, and to his surprise he found that instead of the gas having decreased there was an actual increase of consumption of over 10 per cent. for three years.

Cassier's Engineering Magazine.—The second number of this capital monthly contains a series of excellent articles. There is one, beautifully illustrated, on the technical schools of America, which deals with the Sibley College Laboratories of Cornell University; another on "The Influence of Steam Jackets;" a third on "Electric Power Distribution," with 11 full-page illustrations; and a fourth, which should be of use in electric lighting stations, on "Steam Power and the Coal Bill."

The Electric Light in Hungary.—Messrs. Siemens and Halske, of Berlin, are erecting a plant which will be used for the illumination of the town of Pzathmar, in Hungary. The central station will be situated nearly a mile from the centre of the town, from whence the current will be transmitted to a battery of accumulators in the theatre, from where it will be distributed as required.

Electrical Exhibition, Moscow, 1892.—From our contemporary the *Bulletin International de L'Electricité* we understand that the electrical exhibition which is to be held at Moscow will be open from April 14th to October 14th, 1892. The exhibition is organised by the Moscow Section of the Imperial Technical Society of Russia. The exhibits will be distributed into eight groups, as follows :—Group 1 : Electric lighting and transmission of power over distances. Group 2 : Telegraphy, telephony. Group 3 : Electro-technology (electro-metallurgy, electrolysis, galvanoplastie, &c.), applications of electricity to railways, to marine purposes, to military art, to medicine, and to domestic economy. Group 4 : Electric piles, accumulators, static machines, thermo-electric batteries, transformers, electric motors. Group 5 : Motive power—boilers of various kinds. Group 6 : Scientific apparatus. Group 7 : Technical novelties in all branches. Group 8 : Literature, schemes, designs, diagrams, &c., pertaining to electricity.

Electric Lighting at Taunton.—The Taunton Town Council have come to a decision to negotiate for the purchase of the Electric Lighting and Gas Companies. The proposal has come as a complete surprise to the directors of both companies. The Electric Lighting Company has as yet paid no dividend, but authorities state that if the town took over the concern it could be made to work at a profit. The companies may not wish to sell, and in that case it is not at all unlikely that the council would resort to compulsory powers.

The Price of Gas.—Commenting on the rise in the price of gas, which was recently announced by the Gas Light and Coke Company, our contemporary, *The Gas World*, thinks that the feeling of those who demur at paying a higher price for gas is, that all the benefit of the increase goes to the company and its proprietors. It never occurs, says our contemporary, to the penny-a-liners who get up those sensational paragraphs, that if the price of gas is increased, the proprietors have to suffer, inasmuch as they must be content with smaller dividends than they have been hitherto receiving. If such is the case, why not reduce the price still lower instead of advancing it? At all events the action of the company is distinctly favourable to the progress of electric lighting.

Reduce the Coal Bill.—One-sixteenth of an inch of scale on the interior of a boiler involves the burning of 15 per cent. more fuel; therefore as the solid deposit contained in water must be removed before that water becomes steam, *the boiler is not the place where this process should be carried out.* An engine may be ever so economical and efficient, but all the advantages disappear when the boiler acquires a thin coating of scale on its interior surface. It is evident that the fuel can never do its maximum duty unless the boiler *is kept always clean*, and this is only possible when the water enters in a sufficiently pure state to leave *no scale.*

Progress of Telegraphs and Telephones at Georgetown.—We hear that Mr. Samuel Vyle, A.S.T.E., Government Electrician at Georgetown, Demerara, is at present supplying and fitting 200 more telephones at Georgetown; a 50-wire exchange at New Amsterdam, which is 70 miles from Georgetown; whilst he is renewing the telegraph lines not only with new poles, but also with new insulators (12,000), and No. 14 copper wire. It is stated that half of the colony's lines will be renewed this financial year. A means of communication with the Gold Fields centre is about to be carried out by the laying in the bed of the river Esseguebo leading up to it.

The World's Fair Electricity Buildings.—Referring to the note in our issue of November 13th in which we stated on the authority of the *Times* that the electricity hall had been condemned as unsafe, we notice that our comtemporary, *Western Electrician*, makes some very strong remarks on the matter in a recent issue and flatly contradicts the statement as to the building being unsafe. In order to obtain an authoritative statement of the facts, however, the *Western Electrician* brought the matter to the attention of the chief of the Bureau of Construction, who in a written reply said:—"The foundations of the electricity building are firm and strong. . . . . The only criticism that can be made is that we are pushing our prudence to extremes; but I do not propose to take the remotest chance in construction when such enormous interests are at stake." The electrical building will be perfectly safe, says our contemporary, and it will be by far the finest structure for the display of electrical apparatus ever erected.

"L'Electricien."—We learn that some changes have taken place in the management of our French contemporary, *L'Electricien*, and that from the 1st inst. the editorial department will be under the supervision of the following committee of gentlemen, well-known in the electrical world:—M. Monnier, Professeur à l'Ecole Centrale des Arts et Manufactures; M. Eric Gérard, Directeur de l'Institut Electrotechnique Montefiore; M. Felix Lucas, Ingénieur en Chef des Pont-et-Chaussées, Administrateur des Chemins de fer de l'Etat; M. Emile Dieudonné, Ingenieur-Electricien; M. Eugène Meylan, Ingenieur-Electricien; M. Montpellier, Fondateur de la *Revue Internationale de l'Electricité.*

NEW COMPANIES REGISTERED.

Central Electrical Company, Limited.—Capital £50,000, in £1 shares (of which 5,000 are preference, and 45,000 are ordinary shares). Objects: To adopt and carry into effect an agreement to be made with Knud Sando, and to carry on the business of electricians, mechanical engineers, suppliers of electricity for the purposes of light, heat, motive power or otherwise, and manufacturers of and dealers in all apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation and employment of electricity. Signatories (with 1 share each): P. H. H. Nickson, 221, Gipsy Road, West Norwood; H. W. Brett, Bourneside, Weybridge, S.W.; T. Hallamore, 34, Old Broad Street, E.C.; J. P. O'Donnell, 2, Great George Street, S.W.; Knud Sando, 47 and 48, Old Broad Street, E.C.; W. Woodhead, 4, Station Buildings, West Green, Tottenham; H. B. Thurston, 50, Norwood Road, Herne Hill, Surrey. The number of directors is not to be less than three, nor more than seven. Qualification, £100. Remuneration, £100 per annum each, and 10 per cent. of the net profits divided between them. Registered on the 28th ult. by T. T. Hull, 22, Chancery Lane, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrical Purification Association. Limited.—The annual return of this company, made up to the 30th ult., was filed on the 31st ult. The nominal capital is £25,000 in £1 shares, of which 17,176 are taken up. The full amount has been called on 12,176 of these, resulting in the payment of £11,657, and leaving £517 unpaid. The other 5,000 have been issued as fully paid. Registered office, 22, Great George Street, Westminster, S.W.

"Eclipse" Electric Lighting Syndicate, Limited.—The annual return of this company, made up to the 31st ult., was filed on the 1st inst. The nominal capital is £20,000 in £1 shares, of which 15,357 have been taken up. Of these 4,580 have had the full amount called, resulting in the payment of £4,580, while the remaining 10,777 were issued as fully paid. Registered office, 2, Pancras Lane, Queen Street, E.C.

CITY NOTES.

The Direct United States Cable Company, Limited.—The directors of this company have resolved upon the payment of an interim dividend of three shillings and sixpence per share free of income tax, being at the rate of 3½ per cent per annun, for the quarter ending December 31st, 1891, such dividend to be payable on and after the 23rd instant. £5,000 has been placed back to the reserve fund and £4,982 15s. 3d. has been carried forward.

City and South London Railway Company.—The *Financial News* states that the directors of the City and South London Railway Company are prepared to receive applications for the unallotted balance of the five per cent. perpetual preference shares.

The Western and Brazilian Telegraph Company, Limited.—The Western and Brazilian Telegraph Company, Limited notify that direct communication by their cables with Montevideo and Buenos Ayres is now restored.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of December were £3,400 as compared with £3,089 in the corresponding month of last year.

The Eastern Extension, Australasia, and China Telegraph Company, Limited. The traffic receipts for the month of December amounted to £38,898, as against £43,482 in the corresponding period of 1890, showing a decrease of £4,584.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of December were £55,830, as against £58,058 for the same period of 1890, a decrease of £2,228.

The Great Northern Telegraph Company. Receipts in December, 1891, £22,400; 1st January to 31st December, 1891, £282,600; corresponding months 1890, £280,000; corresponding months 1889, £274,800.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of December, 1891, are £2,180, as against £2,130 in the corresponding period of last year.

The West India and Panama Telegraph Company. The receipts of the West India and Panama Telegraph Company for the two weeks ended December 31st, show a decrease of £252 as compared with the corresponding period.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Dec. 31st.)	Closing Quotation. (Jan. 7th.)	Business done during week ending (Jan. 7th, 1892.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	98 — 101xd	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	50½— 51½	50½— 51½	51	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	88 — 89	88½— 89½	89⅞	88⅜
2,849,510*l*	Do. do. Deferred	Stock	14 — 14½	13⅜— 14¼	14¼	14
130,000*l*	Brazilian Submarine Telegraph, Limited	10	10¾— 11¼xd	10½— 11 xd	10⅝	...
53,200*l*	Do. do. 5 p. c. Bonds	100	101 —104	102 —105	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	101 —105 xd	103 —107 xd	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛— 3⅜	3⅛— 3⅜	3¼	...
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2⅛— 2⅜	2⅛	...
40,000*l*	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3½— 4½	...	...
50,000*l*	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	2⅜	...
30,152*l*	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	6	5½— 6	5½— 6	6 1/16	5⅞
$7,716,000	Commercial Cable, Capital Stock	$100	149 —151 xd	150 —155 xd	153½	151
224,850*l*	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅜— ½	⅜— ½	...	...
100,000*l*	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	5	5¼— 5⅜xd	5¼— 5⅜xd	...	...
16,000*l*	Cuba Telegraph, Limited	10	10 — 11	10 — 11	10⅜	10¼
6,000*l*	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931*l*	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3¼— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9½— 10½	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅜— 11⅛	10⅜— 11⅛	11⅛	11 1/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13 7/16— 14⅛	14 — 14¼	14¼	14
70,000	Do. 6 p. c. Preference	10	14⅜— 15¼	15 — 15½	...	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	109⅜	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	108½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15⅜— 15⅝	15 5/16	15⅛
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	102 —105 xd	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	102 —105 xd	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	107 —110	107 —110	109¼	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	101 —104 xd	101	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	101 —104 xd	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6 — 6½xd	6 — 6¼xd	6⅜	5⅞
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2⅛— 2⅜	2⅛— 2⅞	4	2⅜
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3⅜— 3¾	3¾— 4	4 5/16	2½
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	2¼— 2½	2⅜— 2⅝	2 13/16	2 7/16
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅞— 10⅛	9¾— 10⅛	10 1/16	9⅝
180,042	Do. do. 6 p. c. Preference	10	14⅜— 15	14⅜— 15	14 3/16	14¼
150,000	Great Northern Tel. Company of Copenhagen	10	19¼— 19¾	19 — 19¼xd	19½	19
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	107	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20½— 21½	20½— 21½	21¼	20⅜
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	43	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	4 — 5	4 — 5	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8⅜— 9¼	8⅜— 9¼	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9½— 10	9½— 10	10	9 1/16
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4¼— 4½	4 7/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12¼— 12¾	12¼— 12⅝	12⅝	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12½	12 — 12½	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	105 —108 xd	105 —108 xd	106½	105
250,000*l*	Do. (issued at 5 p.m., all paid)	25	29 — 32	29 — 32	...	...
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	6½— 7½	6 — 7	...	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000*l*	Reuter's Limited	8	7⅜— 8¼	7¾— 8¼	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8½— 9	8½— 9	8⅝	8½
7,900	Do. do. do. 7 per cent. pref.	5	7¼— 7⅜	7¼— 7⅜	7 5/16	7¼
3,381	Submarine Cables Trust	Cert.	117 —122	117 —122	119½	118
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4¼— 4⅜	4 — 4½	4¼	4¼
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	42¾
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	100 —103 xd	102½	102
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	80 — 90 xd	80 — 90 xd	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8 xd	7 — 8 xd	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	97 —100	98 —101	99⅜	99
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	4¼	...⅜
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 — 101xd	97 —101 xd	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10¼— 10⅜	10¼— 10⅜	...¶	...
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6⅜	6¼— 6⅜	...	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	4 — 4½	4 — 4½	...	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1⅞	1⅝— 1⅞	1⅞	1¾
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9 — 9½	9 — 9½	9½	9¼
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	7½— 8½	7½— 8½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	10J	98 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼— 6⅜	6¼— 6⅜	6⅜	6¼

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7¼—7⅜.—Electric and General Investment, Shares of £5, £1 paid, 2⅜—3¼.—European Sims-Edison Torpedo Company, shares of £20, fully paid, 20—20½.—Halifax and Bermuda Cable, 4½ per cent. bonds 85—95.—House to House Company (£5 paid) 4½—5.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares, £5 fully paid, £5⅜—£6, 1st Preference Cumulative 6 per cent., £5 fully paid, £5½ to £6.—†Liverpool Electric Supply, Shares of £5, £3 paid, 2¾—2⅞. Shares of £5 (fully paid), 4⅞—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅛—1⅜. Do. 6 per cent. Preference, 1⅜—2¼.—Manchester, Edison and Swan Company, £9 (£1 paid), ½—⅝.—National Telephone Debentures, 2½—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 1¾—2.—£5 Preference, fully paid 3½—3⅝.—Ward's Electric Car, £10 paid, ⅜—1.

† Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—3½ per cent. (December 10th, 1891).

TRANSMISSION OF POWER FROM A CENTRAL STATION.

[A COMMUNICATION.]

TOWARDS the close of 1890, Mr. E. Claussen, Imperial Architect, read before the members of the Berlin Society of German Mechanical Engineers two papers "On Motors for Small Industries." The papers were so well received that the author was invited last May to address the Berlin Polytechnic Society on the same subject. This was also favourably received, and after consultation with his colleague, Mr. L. Glaser, and with Dr. H. Albrecht, he decided to rearrange the subject matter of those papers, and to publish it in book form, so as to reach a wider circle of readers. This work has just been issued by Mr. George Siemens, of Nollendorfstrasse, 42, Berlin, under the title of "Die Kleinmotoren und die Kraftübertragung von einer Centralen" ("Small Motors and the Transmission of Power from a Central Station"). The book, which is intended to reach ordinary readers, is written in simple language, and its object is to effect an improvement in the depressed condition of German small industries.

Extending over 140 pages, the work deals with the economic importance of small motors—small motors whose working depends upon chemical affinity, such as gas, petroleum and benzine engines, small motors whose source of power is heat, as hot air and steam engines, and small motors to be worked by transmission of power from a central station, as water, compressed air, and electro-motors. The engines described are the Otto, the Kaselowsky gas and petroleum engine, and the recently-constructed Capitaine petroleum motor; the Rider-Monski and the Benier hot air engines, the Hoffmeister steam engine, and Hoppe's water motors. The dynamos and motors of the German Electricity Works of Aix-la-Chapelle are considered, and also the Aron meter. In the case of the gas, petroleum, and hot-air motors, which are treated of from 1 to 6 H.P., and for a working year of 3,000 hours, particulars are given regarding the initial cost of engines of various powers, together with details of working expenses per effective H.P., and the total cost for the year.

The following table is a summary of the working expenses, the figures being given in pfennigs, of which 100 = one shilling :—

COMPARATIVE TABLE OF WORKING EXPENSES OF VARIOUS MOTORS FOR ONE EFFECTIVE HORSE-POWER HOUR.

	Horse-power of small motors.	1.	2.	4.	6.
		Pfngs	Pfngs.	Pfngs.	Pfngs.
Large condensing steam engine.	40 H.P.	8·7	8·7	8·7	8·7
	60 „	7·1	7·1	7·1	7·1
	100 „	6·4	6·4	6·4	6·4
	150 „	5·3	5·3	5·3	5·3
Small motors. Independent.	Manual labour	402	402	402	402
	Petroleum engines:				
	Kaselowsky with petroleum duty	30·6	23·2	19·1	16·6
	Kaselowsky without petroleum duty	23·6	16·9	13·5	11·7
	Capitaine with petroleum tax...	19·9	14·3	11·1	...
	„ without petroleum tax	15·7	10·8	8·3	...
	Hot air motors:				
	Rider-Monski	17·6	15·2	...	...
	Benier	...	...	10·6	9·2
	Steam engine:				
	Hoffmeister	29·1	23·1	19·6	18·6
	Gas engines	25·4	19·9	16·2	14·8
Dependent.	Transmission from a central station with the use of:				
	Water motors	13·6	13·6	13·6	13·6
	Compressed air motors...	14·1	14·1	14·1	14·1
	Electro-motors	12·5	12·5	12·5	12·5

The summary of figures given in the table are based upon detailed calculations made and printed in preceding pages. In the case of the transmission of power by the three methods, a production of 3,000 H.P. per hour, and for 3,000 hours yearly has been estimated. It will be seen that according to Mr. Claussen the cost of producing one electric horse-power with a station of that capacity amounts to 1½d. (12·5 pfennigs); with water motors, 1⅝d. (13·6 pfennigs); and with compressed air motors, 1¾d. (14·1 pfennigs).

THE WIRING OF HOUSES FOR THE ELECTRIC LIGHT.

BY ED. C. DE SEGUNDO, A.M.I.C.E.

(*Concluded from page* 6.)

II.—THE INTENSITY OF CURRENT THAT SHOULD BE ALLOWED IN THE WIRES IN A BUILDING.

There are two very good reasons why it is important to determine the allowable intensity of current throughout the system of conductors.

(*a*) Because too great an intensity means dullness in some of the lamps, and varying brightness in others, and, if carried to excess, danger of fire; and (*b*) Because too small an intensity means a waste of money for unnecessary copper in the mains.

Suppose a house were fitted with wires intended to carry 1,000 ampères per square inch. This intensity is allowed by the Phœnix Fire Office, but they recommend that it should not be exceeded. Suppose the houses were so large that the furthest lamp was 200 yards away from the source of supply, that is, from the point where the supply mains entered the house, and suppose the pressure of supply to be 100 volts; by the time the current had got to this farthest lamp the pressure would have dropped to 88·5 volts, under which conditions a 100-volt lamp would not burn brightly. Should three-quarters of the lamps be extinguished, the end one would burn quite brightly.

Consider the case where, through ignorance or otherwise, more lamps were connected to a wire already working at an intensity of 1,000 ampères per square inch, the lamps would burn still more dimly. In the extreme case the wire would commence to smoke, the insulation would soon be rendered valueless, and probably any inflammable material near a joint or weak place would be set on fire.

The author has seen books behind which an overworked or under-insulated wire was run in casing, warped by the heat from the wire which had charred the casing at the point where the fault occurred.

The moral of this is that people whose houses are lighted by electricity should not make indiscriminate additions of lamps without consulting some competent individual as to whether the wires can stand the extra intensity involved.

It is very good to fix a limit for the intensity of the current; but why 1,000 ampères per square inch should have been chosen without any other conditions being imposed it is difficult to see.

At 1,000 ampères per square inch a strand of No. 18 wire would carry 1·8 ampères. Now, 3 to 4 ampères would probably not raise the temperature of this wire enough to injure the insulation, and there is no reason why, if the drop in the electromotive force is of no importance, or for a very short length, the wire should not be made to carry this current, more especially if it is effectively protected against carrying much more.

Evidently the size of the conductors should be so proportioned that a given per cent. of drop in the furthest lamp is not exceeded. After this condition the limiting 1,000 ampères per square inch specification for any conductor might with advantage be enforced in some cases.

The additional stipulations in the rules compiled by the Institution of Electrical Engineers that the temperature of a wire at full load shall not exceed a given amount, is wise, more especially as recently it has been experimentally demonstrated that copper has a deteriorating effect on rubber at all times, and that this action is aggravated by a rise in temperature to, say, 150° Fahrenheit.

III.—MANNER OF ERECTING WIRES.

A point of much importance, but one which, until recently, was quite overlooked even by experts, is, that the system of placing the conductors in a building should be such that they are readily accessible for examination, and that any fault that may arise may be easily localised and remedied.

Take, for instance, a practical example :—

A house is wired for 30 lamps. The wires are run in the cheapest way, namely, two mains are run and leads are teed off where required to feed lamps. A main fuse is inserted only between the source of supply and the mains. On testing,

evidence is found of a short circuit; it may be that a switch has been wrongly connected up; it may be that two bare ends of wire intended to be attached to the terminals of a lamp have been inadvertently twisted together; it may be that in fitting up a lamp served by flexible cord, one strand of the fine No. 40 copper wire is bridging across to the other pole. Whatever is the cause, whether easily remedied or not, it has to be localised before it can be removed, and if the wires have been run as before described the work involved in discovering the fault may be very great and tedious.

Suppose, on the other hand, the wires have been fixed so that not more than 5 16-candle-power lamps or their equivalent are fed by any one circuit, then should a fault appear on testing, the faulty circuit can be easily found by first taking out all the fuse plugs and replacing them one by one and testing each time.

It has become universal in good practice to place the wires, as far as possible, in double grooved wooden troughs, called casing, which is subsequently covered by a lid called the capping. The reason is not so much for insulating purposes as to protect the wire from mechanical injury in fixing, and to preserve the insulation from contact with foul or acid gases, or any such subtle influence, tending to lead to deterioration of the insulating material surrounding the conductor. Now, clearly, to be effective, this principle should be carried out continuously, and yet it is common experience to find casing run just where it is convenient and easy, apparently for the sake of appearance, while the casing stops on one side of the wall and the wire is taken through a hole and re-enters casing on the other side. In passing through a partition of wood, this is allowable, but should not be permitted in going through brick, cement, or lath and plaster.

Our English practice in this respect is a great contrast to that in Switzerland, where in many of the large hotels and other public places the lamp leads are stapled down after the manner of bell leads.

Now as regards the economical question of the different systems on which the wires are put into the house. From the point of view of economy in power no one system has any advantage over the other, for whether lamps be placed all in series or in parallel, or some in series and some in parallel, n times the electrical energy is required for n lamps of the same candle-power and type that is required for one lamp. By placing lamps in series, considerable economy is effected in the size of the mains, for the current flows through one lamp after another, and hence the main need only be of sufficient size to carry this current, whereas if the lamps be in parallel—that is, arranged as bridges from one pole to the other—the intensity of current required will be about n times that for one lamp, and since the heating effect varies as the square of the current multiplied by the resistance of the circuit (independently of the electromotive force), it is evident that if the current be doubled (keeping the wire the same size) four times the tendency to heat will exist, and the area of the conductor must be quadrupled in order to keep the tendency to heat the same.

The great drawback of series working is that should one lamp burn out, all the lamps in series with it will be extinguished, since the circuit is thereby broken. This is an insuperable disadvantage for domestic lighting, and thus lamps in series are never adopted in private houses. This could be obviated by using a lampholder containing an automatic means of short-circuiting the lamp terminals immediately the film gave out. But the disadvantage of the greatly increased electromotive force is another reason why this system is never used for domestic lighting.

A method much to be recommended is to run mains and sub-mains to the terminals of a distributing fuse board, from which leads are taken off through a fuse on each pole to every lamp individually.

The advantages are safety, convenience in testing, and it is found that the economy in being able to use wire less heavily insulated, and the time saved by the absence of so many joints, more than compensates for the great increase in the number of wires, size of casing, and cost of boards. The author has recently adopted this system in several cases in which he has been consulted, with most satisfactory results, particularly as regards insulation resistance.

IV.—Type of Safety Precautions.

It is universal experience that no mechanical or other device should ever be allowed the possibility, even, of passing out of control.

This is effected, in houses wired for the electric light, by purposely weakening the capacity of the conductors to carry current at some point in every circuit to such an extent that only the requisite current for that circuit at full load can be carried safely by this weakened part.

Should the current from any cause rise to, say, 50 per cent. more than the full normal current, the weak place would become so heated that it would fuse and interrupt the current in that circuit, thus preventing the main wires from becoming over-heated. The action is analogous to that of a fusible plug in steam boilers.

In practice, this weakening of the conductor is effected by a special apparatus consisting in diagram of a frame composed of some insulating material over which a wire of an easily fusible alloy is stretched, either end being fixed to a terminal. The conductor to be protected is cut, and either end is attached to a terminal. It is good practice to place such a frame not only on the conductor going to the lamps, but also on that coming from the lamps, so to speak, the reason being that if only one conductor is protected, the other would in no way be protected against leaks to earth. It is usual to place both frames side by side on the same base. In fuses designed for use in circuits working at a high electromotive force, special precautions have to be taken to avoid the possibility of a short circuit, or of an arc being set up between the terminals of a frame.

The action of the fuse, or cut-out, is a very good practical example of the fact that the heating of a conductor is conditioned solely by the intensity of current flowing through it, quite independently of the electromotive force at which it is flowing; a fuse which is designed to blow at or about 10 ampères will do so, whether it be placed in a high or low tension circuit. The reason of this is simply that a fuse is placed in series and not in parallel, that is to say, it is an apparatus for controlling the current, not the electromotive force.

Although the electromotive force does not condition the sectional area of the fusible wire, it has to be considered when designing the frame, and, indeed, it often occurs that when the fusible wire melts, the electromotive force between the terminals of the fuse frame may arise for an instant sufficiently to cause the current to bridge across the air gap, thus establishing what is known as an arc. This arc may then continue (for an arc is maintained by far less pressure than that which was necessary to start it), and the function of the fuse is lost.

It is difficult to say what length the wire should be for any given electromotive force. The determination of the maximum air gap that a given electromotive force will start an arc over is no criterion for the design of fuses, since if the fuse blows in consequence of simple overloading, when too many lamps are switched on, the electromotive force may rise considerably by self-induction, depending upon the intensity of current flowing at the instant when the circuit is broken.

The effect of self-induction on the electromotive force may be considered as somewhat analogous to the increase of pressure in a high pressure water service pipe when a cock or valve is suddenly shut off.

Thus the electromotive force at the terminals of a fuse may rise to almost any value.

Numerous devices have been tried to make fuses certain and efficient in their action, which cannot be described here; but one point is important, that the fusible wire should be long enough to eliminate the cooling action of the attachment to the terminals, for a wire of No. 20 gauge, which, in a length of 2 inches would fuse with 6 ampères, would pass 9 or 10, if only half an inch long.

The author is of opinion that there should be as few fuse boards in a house as possible, and they should in all cases be so placed as to be readily accessible for inspection or repair.

In regard to the position of the fuses a word or two may be said. The use of a fuse is undoubtedly not only advisable, but often necessary, in certain cases, but the practice of relying on a multitude of fuses to cover defects of workmanship or inferior quality of material is reprehensible in the extreme.

A principle the author has adopted in several installations in regard to which he has been consulted, is to place all the

fuses throughout the house, if possible, upon one well-insulated distributing board, and, in the case of large installations, to place several such distributing boards in convenient positions in the building. Thus the circuits and run of casing are only interrupted for switches and fittings, and, in many instances, a large number of the switches can also be collected on the distributing board.

The importance of continuity in the wiring becomes at once evident when it is considered that fuses alone cannot perfectly guard against, or prevent risks from leaks to earth, the risk of earth leaks is never wholly absent, and is only reduced to a minimum by proper precautions, and by using judgment and foresight in choosing the position for the wires, fuses, switches, and fittings.

The Insulation Resistance of the Installation as a whole.

The insulation resistance has been referred to in the foregoing lines, and there remains but one or two general remarks to be made.

A question which suggests itself at once is, What degree of insulation resistance should a well executed installation possess? This question, however, admits of no unequivocal answer, for the insulation resistance is affected by many circumstances which cannot be readily distinguished from each other.

Thus, if on testing, a low degree is found, it may be due to deterioration of insulation of the cable at some particular point, or to water and moisture having got into the casing somewhere, or to the general state of the weather being damp. Further, the insulation one would expect to find would naturally vary with the type of installation.

Generally, for the same type of installation and for equal quality of work and material, the insulation resistance is found to vary inversely as the number of lamps, roughly speaking, and this led to Mr. Heaphy, in the Phœnix Fire Rules, to draw up a table on which the insulation resistance required is varied according to the number of lamps contained in the installation, but though this may be taken as a rough guide, it is only an empirical determination, and is not in any way based upon scientific considerations. A consulting engineer must use his own judgment, taking all conditions into account, as to what insulation an installation should show.

Subsequent general deterioration can only be minimised by sound workmanship in the first instance, and by frequent intelligent testing. Here, again, the importance of wiring a house so as to facilitate testing is prominently brought forward.

The author has endeavoured to confine himself to general remarks on the subject, and can only repeat, in conclusion, that a properly designed electric light installation skilfully carried out under competent supervision may be more free from subsequent risks due to carelessness of the individual than an installation for gas lighting, in some cases immeasurably more so, while if unskilfully executed with inferior material and workmanship it may become a source of annoyance and danger.

Further, he would again draw attention, unnecessarily, perhaps, after what has gone before, to the fact that economy should not be considered of primary importance to the exclusion of efficiency and safety, hence no expense should be spared in the installation of the wires, the quality and position of the safety apparatus, switches, &c., and the design of the fittings. But money may well be saved by adopting simple and efficient fittings in lieu of fittings elaborately ornamented, and by a little thought and common sense in the choice of the positions of the lamps to be installed. It should be borne in mind that the quantity of light necessary for a given space not only depends upon circumstances, but is also—especially in domestic work—very much a matter of opinion; hence, intending users of electric light would do well to examine the methods adopted in their friends' houses, and judging for themselves as to how many lamps will be required, instead of placing themselves unreservedly in the hands of contractors, some of whom, when placed in this position, may find the struggle between duty and inclination somewhat severe.

The Electric Light in France.—Messrs. Ferranti have just completed the electric lighting station at Nimes in France, and current is being supplied to 6,000 lamps.

THE POLESCHKO TRANSFORMER.*

ALL existing transformers may be classed in two groups; in the one, such as the Ruhmkorff coil, the Gaulard and Gibbs and the Swinburne "Hedgehog" transformer, the iron core is in the form of a cylinder; in the other the iron core is in the form of a closed geometrical figure, annular as in the Zipernowsky, Deri and Blathy, or otherwise, as in the Westinghouse, Ferranti, &c. In transformers of the first group, the lines of force generated in the iron core by the action of the primary helix are given off as a bundle from the north pole and proceed to the south pole across the outer space, where they form closed curves of all possible radii. The secondary coil in this case is in the intermediate space between the iron core and the exterior system of the lines of force. In transformers of the second group, all the lines of force generated in the iron core by the action of the primary coil remain entirely in the core itself without appearing at the exterior. These lines of force remaining in the iron core can only pass in the interior of the spirals of the secondary coil or they may encircle the outer

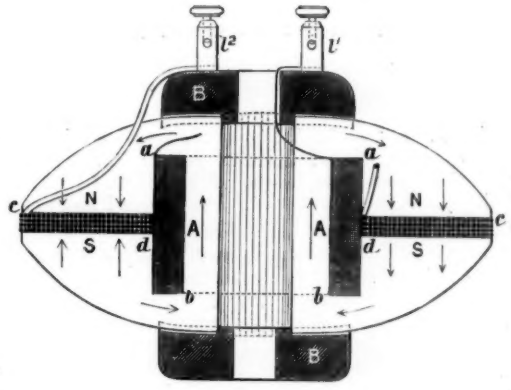


FIG. 1.

secondary coil. In both cases the lines of force never touch the secondary helix itself.

In transformers of the first group, as well as the other, the secondary coil is not traversed by all the lines of force which circulate in the iron. It is only a small portion of the lines of force which detach themselves, so to speak, from the general magnetic flow which reaches the secondary coil in closing along short elementary curves.

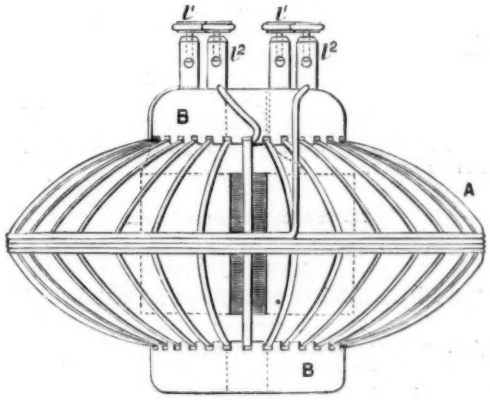


FIG. 2.

Recently however, Mr. Arcadius Poleschko, of St. Petersburg, Russia, has devised an arrangement, shown in the accompanying illustrations, by which the magnetic flux in the iron is all made to pass entirely across the secondary coil. In this apparatus the secondary helix $\pm l_2 \mp l_2$ is influenced in the first place by the current in the primary helix $\pm l_2 \mp l_2$,

* *Electrical Engineer*, of New York.

and in addition by the whole of the magnetic flux which is developed in the iron core, A A, by the action of the primary coil upon this core.

The core consists of blades or thin plates of sheet iron. The plates, A A, the shape of which is shown in fig. 1, are arranged in the form of a ring and inserted at the top and bottom into two insulating hubs, B B. The primary coil $\pm l_1 \mp l_1$ is arranged in the vertical cavity, *a b*, within the interior of the core, fig. 1, and the secondary coil $\pm l_2 \mp l_2$ is arranged outside the first in the form of a flat ring of small height, but of great breadth, in the direction of the diameter of the ring. The secondary coil of this shape is placed in a narrow channel, *c d*, in the core, extending substantially at right angles to the slot, *a b*. The ends of the two coils are led to corresponding terminals on the insulating hub.

The channel which cuts the mass of the core across the direction of the lines of magnetic force increases very considerably the rapidity of demagnetisation and diminishes the hysteresis. The thin iron plates of the core are insulated one from another by air. This arrangement of core has the double advantage of avoiding Foucault currents and of increasing the cooling surface.

REVIEW.

*Practical Treatise on Electricity for the use of Engineers and Constructors.** By M. FELIX LUCAS, Chief engineer of bridges and highways, Administrator of State Railways. Paris: Librarie Polytechnique Baudey et Cie. Pp. 593, large 8vo., with 278 figures.

A comprehensive work, ably and clearly written. The author considers in the first place the mechanical theory of magnetism and electricity. He then passes on to electric measurements, followed by batteries, accumulators and electrostatic machines. The fourth section gives an account of dynamos as electric generators, to the transfer, distribution and transformation of electric energy and lastly to its utilisation. Under this last head M. Lucas treats firstly of the electric light. Here he remarks that the arc light presents the same composition as that of the sun, which is not absolutely correct. He hopes that ultimately it may be practicable to obtain luminous waves directly without the intermediate stage of heat. This end may be reached by rendering the electric undulations sufficiently short. The author then turns his attention to the electrical transmission of mechanical power, to electric traction and to electro-metallurgy. To this last important subject he consecrates merely seven pages. Into other applications of electricity, actual or prospective, the work does not enter. We do not even find any mention of the electropathic appliances which are now so industriously—we had nearly used a harsher term—forced upon our attention. The illustrations are not only numerous but appropriate and good. Where chemical formulæ are used the old notation is adhered to, France being the head-quarters of resistance to novelties in science. The great defect of this book—otherwise excellent—is that there is no index.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

13,522. "Improvements in instruments for indicating and registering the state of the charge in accumulators." G. ROUX. Dated August 28th. 8d. Is essentially composed of a cylindrical body with flat ends, and suspended at the top end by a very fine rod. This body, the length of which is slightly inferior to the height of the liquid contained in the accumulator, is weighted and counterpoised in a suitable manner, and its rod is attached at one end of a very short lever, which is in a horizontal position when the accumulator is charged to saturation. On the same axle than that of the short lever, and making with the said lever a convenient angle, is mounted a screwed rod provided with a counterweight, the shifting of which allows of the regulation of the instrument. Perpendicularly to the short horizontal lever, and mounted on the same axle, is mounted an equilibrated hand or pointer, which is free to move in front of a horizontal scale divided into equal parts, or any other graded scale. 2 claims.

15,248. "Improvements in dynamos and electric apparatus for charging accumulator cells and running lamps at the same time." W. B. SISLING, W. H. SCOTT, and L. SCOTT AND COMPANY, LIMITED. Dated September 26th. 8d. The inventors arrange two commutators on one armature, one of the commutators, called the "main commutator," being designed to give an approximately constant E.M.F. for the working circuit or at the lamps, and the other or "charging commutator" being arranged in series with the main commutator to add the extra E.M.F. required for charging the cells, without increasing the speed at which the dynamo is driven. 2 claims.

15,777. "Improvements in electric meters." B. J. B. MILLS. (A communication from abroad by T. Blein, of Lyons.) Dated October 6th. 8d. Consists first of a clock movement working a commutator having four specially shaped arms, which makes exactly one revolution in an hour. Second, of an ampèremeter or galvanometer traversed by the current, the vertical axis of this galvanometer carries a needle whose curved point moves on the upper face of the commutator, approaching nearer to the centre thereof according as the intensity of the current increases. Third, of a recorder or counter operated by the clock movement by means of gearing, which works only when the needle is in contact with one of the arms of the commutator. Fourth, of two electric magnets, the first serving to put in operation the clock movement as soon as a current traverses the apparatus, and the second operating the counter gearing. 3 claims.

16,222. "Improvements in lanterns or lamps for arc electric lights and in posts or columns therefor." A. L. SHEPARD. Dated October 11th. 8d. An important feature in the said invention consists in suspending the lamp or lantern from the post or column by means of one arm, extension or support, the said lantern or lamp being constructed in two parts rotatably supported upon the latter, and so arranged that upon the release of a suitable catch or fastener the said parts can be together rotated or turned into any convenient angle relatively to the said lamp post or column. Upon the release of another catch or fastener the lower part or globe of the said lantern or lamp can be lowered or caused to descend a suitable distance whilst the upper part containing the lamp mechanism remains stationary. 3 claims.

16,613. "A method of renewing and a preparation for fixing filaments in incandescent lamps." J. MOHRLÉ. Dated October 18th. 8d. In the first instance a small slit is made in the centre of the lower or widened part of the glass bulb. Then with the assistance of a blow flame the edges of this slot, which widens slightly in the centre, are bent open so that the small opening is widened, the edges standing outwards. Then the broken filament is removed and the two platina electrodes are cleaned; the new carbon thread, of optional shape or system, is then introduced through the longitudinally shaped opening. The connecting of the ends of the new carbon thread is now done immediately on the platina electrodes by means of a new substance compo·ed of heated silver graphite of pulverised carbon (heated piasaba) and of a solution of copper. After the new carbon filament has been fastened in place the slot is blown by the flame, and is bent together again and the exhaust pipe is applied, the exhausting and closing up are then done in the known manner. 3 claims.

17,747. "Improvements in the manufacture of electrical insulating materials." J. R. THAME. Dated October 21st. 4d. Claims:—1. The preparation or manufacture and use of electrical insulating materials from cellulose obtained from chemically prepared wood pulp the material after being moulded being treated with gums or resins to render it hard, the solvent of the gums being distilled off for use or removed substantially as set forth. 2. The preparation or manufacture and use of insulating material by incorporating slate dust (*i.e.*, waste slate ground up) with soda or potash silicate the plastic material so obtained being first slowly dried and afterwards submitted to a red heat in a suitable furnace or retort substantially as set forth.

17,266. "Improvements in electric railways." J. C. FELL. (A communication from abroad by C. Richter, of America.) Dated October 28th. 8d. Where the rails are used as conductors they are laid in sections. Each section is separated from the two contiguous sections of the same line of rails, but all are connected by switches arranged between the sections. The sections are connected at their contiguous ends by wires to a common switch which connects the co-terminus rails of each section of the two lines with those of another section, and these switches are normally closed, so that the line is continuous through the rails alone when no car is run upon the track. The car carries an electric motor of any suitable type, which has its poles connected to contact rollers or brushes, one at each end of the car, and the points of contact of these brushes or rollers are separated a distance a little greater than the length of any section, so that the car may, with these points of contact, bridge the whole section of rail, including the space at one end, so as to separate that section from the other rails contiguous thereto. The car also carries a magnet depending therefrom in line with the series of switches adapted to operate the switch and hold it open while the car is passing over it so as to put the current from one contact point through the motor on the car, and thence to the other contact point, while said switch is thus held open. 3 claims.

17,558. "Improvements in apparatus for testing insulation resistance of electric wires." J. J. RATHBONE. Dated November 1st. 6d. A compass is fixed to a movable or pivoted glass base or other suitable insulating material. On this base is fixed a terminal near to the needle, but not in contact with any part of it, the position being so arranged that the needle is pulled over, when a current generator

* *Traité Pratique d'Electricité a l'Usage des Ingénieurs et des Constructeurs.*

is applied for a distance of about three-eighths of an inch, providing the circuit to be tested is free from leakage. For this purpose the line wire to be tested has one end removed and affixed to the terminal, so that on applying the generator to the terminal the needle is (deflected) pulled over to a stop arranged in its path. If it is not free from leakage, the needle will not be deflected so much by reason of the current going to earth. The amount of deflection can be indicated by turning the base on its pivot for a pointer on the base to move over a graduated scale the distance required to bring the needle opposite the terminal by the current, the degrees of deflection representing the amount of leakage. 1 claim.

17,829. "Improvement in incandescent lamp-holders or suspenders." J. E. CHARNOCK. (Communicated from abroad by C. Charnock, of Russia.) Dated November 6th. 8d. Consists in continuing the parallel slots of the usual bayonet joint for some distance beyond the recess, and then turning the slots towards the edge of the suspender till within a short distance of the same. By turning the globe so that the pegs on the hoop or neck of the same come to the end of the parallel slots, they will drop down in the slots turned towards the edge and rest in the same. The wires of the lamp are thereby removed from the terminals in the suspender and the lamp is switched out of circuit. By lifting and turning the globe back to its previous position, the contact is made again and the lamp relit.

17,851. "Improvements in electric fire and temperature indicating apparatus for ships' bunkers, refrigerating rooms, and other purposes." H. BINKO. Dated November 6th. 8d. The inventor constructs a small vessel or receptacle of thin steel, or other suitable material and shape, and having an elastic property, in which the mercury is contained. To this vessel he fixes hermetically a glass tube, in the upper end of which, after producing a vacuum, one of the platinum wire contacts is sealed; the second contact is produced by connecting the platinum wire to the outside of the vessel containing the mercury.

18,088. "Apparatus to be employed at telephonic switchboards." J. E. KINGSBURY. (Communication from abroad by the Western Electric Company, of Chicago.) Dated November 10th. 1s. 1d. Relates to a form of switchboard designed for rapidity and facility of action. 13 claims.

18,206. "Improved commutator for dynamo electric generators and motors." H. DAVIS, and A. H. STOKES. Dated November 12th. 11d. Consists broadly in reversing the usual construction of commutators by arranging the commutator bars in the form of cylindrical ring and arranging the brushes within such cylindrical ring and causing them to bear upon the inner surface thereof. 6 claims.

18,695. "Improvements in armatures of dynamo electric machines." J. H. HOLMES. Dated November 19th. 6d. To prevent the slip or displacement of the wires, the inventor makes longitudinal grooves along the surface of the iron core and arranges the conductors so that they lie in the said grooves. These grooves are made quite shallow and close, or almost close altogether, so that when the conductors are placed in the grooves the whole, or nearly the whole, of the surface of the core is covered by wires. The iron does not come to the surface between the conductors as is the case in an armature wound on the Pacinotti method. 1 claim.

18,969. "An improved apparatus for measuring the resistance and insulation of electric conductors." W. A. PRICE and W. E. GRAY. Dated November 22nd. 6d. Relates to the "Silvertown Portable Testing Set." 1 claim.

19,068. "Improvements in telephone spring-jack switches." J. E. KINGSBURY. (A communication from abroad by the Western Electric Company, of Chicago.) Dated November 24th. 8d. In the spring-jack mentioned in Patent No. 9,571, 1889, the stud contact is replaced by a point on a metallic strip placed in the same plane as the spring. 3 claims.

19,344. "Improvements in electrolysis in general and particularly in electrolysis of metals." E. PLACET and J. BONNET. Dated November 27th. 11d. Consists chiefly in subjecting the electrolyte to more or less considerable pressure. 22 claims.

20,043. "A combination of telephones and mechanical signals." G. L. ANDERS and C. H. ELLIOT. Dated December 9th. 8d. Consists of a small magneto telephone, fitted into a socket attached to the lever pull or sounding board. 1 claim.

CORRESPONDENCE.

The Use of Accumulators.

As so much has been said about the inevitable losses which the use of accumulator storage entails on an electric supply system we think this is a fitting opportunity to enclose the annual report we have just received from the engineer of the Kensington and Knightsbridge Company, which has been our oldest customer, and has continuously used our accumulators for nearly 7 years. We give you the figures exactly as received although they show a low efficiency during last Januury and February due to the fact that owing to the exceptionally severe weather the temperature was so low that they were working in an exceptionally unfavourable manner. As soon as means were provided for maintaining the battery rooms at a regular temperature, the efficiency at once rose to the average of the year, viz., about 79 per cent. These efficiencies are the actual commercial efficiencies taken at the recording meters, the losses include not only the losses in the batteries themselves but those due to the resistance of the charging leads which connect the distant accumulator station with the generating station. The losses shown therefore are accurately representative of the total losses due to the use of accumulators for that part of the output which passes through them. This at Kensington is one-eighth part of the whole output, so that the use of accumulators in this station during the past year has only entailed the loss of 2½ per cent. in the entire output. Mr. Miller's remarks are interesting in showing that the efficiency obtained from the home batteries, which does not include losses in charging mains, is practically in excess of 85 per cent.

Crompton-Howell Electrical Storage Co., Limited.

January 5th, 1892.

WORK DONE BY ACCUMULATORS IN 1891.

Kensington Court and Queen's Gate Batteries.

Month, 1891.	Charge in ampère hours.	Discharge in ampère hours.	Efficiency amp. hours.	Efficiency watts.
January ...	113,174	77,592	68·6	66
February ...	96,603	74,005	76·6	69
March ...	82,977	73,230	88·3	78·5
April ...	101,021	90,487	89·1	79
May ...	89,257	82,274	92	80
June ...	95,603	88,028	92	80·5
July ...	99,778	91,864	92·2	86
August ...	78,856	71,283	90·5	84
September	75,274	68,416	91	84
October ...	91,814	83,919	91·4	80·5
November...	104,114	96,997	93	86
December...	115,555	104,052	90·5	81·5
Totals ...	1,444,036	1,002,137	88	79·5

Kensington Court only.

Charge in ampère hours.	Discharge in ampère hours.	Per cent. ampère hours.	Per cent. Watts.
45,742	41,277	90	83
46,868	43,142	92	85·5
43,311	40,525	93·5	86·5
39,015	26,549	93·6	86·5
33,873	31,265	92·5	85·5
46,349	42,350	91·5	85

REMARKS.

During January no provision had been made at the Queen's Gate Battery station for heating, so that the efficiency fell very low. During March improvements were made in the system of charging the batteries, hence the increased efficiency.

The efficiency in watts cannot be calculated direct from the figures given for ampère hours, as the results depend upon the proportion of work done by the batteries at each station, owing to the fall of potential in the charging mains to Queen's Gate, the watt efficiency at that station must be lower than at Kensington Court, also it depends on the amount of charging done separately or in connection with the lighting.

A few readings are given showing the efficiency of the Kensington Court home battery, taken by themselves in order to show how considerably the loss in the charging mains reduces the total average efficiency for the year.

(Signed) H. MILLER, *Resident Engineer.*

Kensington Court.

Comparative Tests of an Elmore and Brazed Pipe.

I notice in your last issue a paragraph relating to the comparative tests of an Elmore and brazed pipe.

After giving the figures at which the pipes burst you say, this test, to the "initiated," is absolutely valueless. Why were not the tubes tested under steam pressure?

The reply to this remark and query is, that the Elmore Company is quite content to be able to satisfy the requirements of such unpretentious authorities as the Admiralty, the Board of Trade, and Lloyds, who insist that all steam pipes to be used in passenger steamers shall be tested by hydraulic pressure.

If, however, the ELECTRICAL REVIEW and the "initiated"

above referred to (whoever they may be), are *not* satisfied with these tests, I am perfectly certain that the Elmore Company will be only too pleased to give every facility for testing its tubes under steam pressure, with the distinct proviso, however, that the ELECTRICAL REVIEW'S manager, staff, and friends, will personally conduct the experiments on their own premises, duly notifying to the public to give the locality a very wide berth. After the test the Elmore Company, I think, will fear no further criticism from the wide-spread columns of the ELECTRICAL REVIEW.

Henry Guarracino.

December 31st, 1891.

Fire Insurance and Risks.

Referring to Messrs. Drake and Gorham's letter in your last impression.

Looking at the matter from the standpoint of justness, and fairness, I fail to see why a contractor should be held liable for the fire risks of an installation once his account for the contract is certified and paid; providing he adheres as strictly as circumstances will allow him to whatever rules and regulations the insurance company may lay down.

Unfortunately, however, insurance companies generally fail to see the advisability of employing a technical inspector to report upon installations. The result is that contractors are liable, wherever possible, to take advantage and slide over the rules. Unless some practical man keeps an eye on the work in the interests of the consumer, an installation is the result, which, in course of time, will have a tendency to lower the estimation of electric lighting in the eyes of the public.

If insurance companies would provide for themselves a *technical* inspector to overhaul and report upon the work done (the policy to be withheld until all has been completed to his satisfaction, and in accordance with their—insurance company—regulations), I say if this was done it would considerably relieve contractors of liabilities to which their negligence in many cases exposes them.

W. J., *N.E.R.*

January 5th, 1892.

Elmore Copper.

At the meeting of shareholders in the Elmore Copper Company, Mr. Pilcher stated that the Elmore tubes supplied to him were "an utter failure in every way," &c., whereupon Mr. Elmore explained that their failure was entirely due to the stoppage of the engine used in their manufacture.

I think the reason why the engine stopped is sufficiently obvious, even though it was "made by one of the best engineering firms in the world.

It is to be presumed that the steam pipe of said engine was not made of Elmore copper, but of the ordinary commercial brazed article which is even still to be met with in the "obsolete" cruisers of Her Majesty's navy; and since these brazed tubes are incapable—*vide Elmore's* tests—of enduring a pressure of more than 120 lbs. to the square inch, that of the engine in question naturally burst when steam was turned on, hence the stoppage of the machinery and consequent laminations and lamentations.

H. Edwards.

January 2nd, 1892.

Jan Swammerdam and Galvani.

I do not know who was the first to promulgate the doctrine that Jan Swammerdam, the famous Dutch naturalist of the 17th century, actually performed an experiment with a frog's muscle before the Grand Duke of Tuscany, which forestalled the celebrated discovery of Galvani by a century; but it is given in Mr. Fahie's excellent work, "A History of Electric Telegraphy," p. 175, and it appears to be accepted by electricians. A critic of the "Pioneers of Electricity," in a recent number of the *Saturday Review*, suggested that a better claim to electrical distinction might be made out in favour of Jan Swammerdam than of Thales, for "did he not anticipate by a hundred years Galvani's discovery of 'animal electricity'? Luckless in his lifetime and rated below his true value after death, he is now fobbed off with a footnote." I venture to think that Swammerdam has no title to be considered an electrician at all, and that his celebrated experiment has been misunderstood.

Mr. Fahie, quoting from the "Biblia Naturæ" (vol. ii.), of Swammerdam, describes the experiment as follows:—

"Let there be a cylindrical glass tube, in the interior of which is placed a muscle, whence proceeds a nerve that has been enveloped in its course with a small silver wire, so as to give us the power of raisng it without pressing too much or wounding it. This wire is made to pass through a ring bored in the extremity of a small copper support and soldered to a sort of piston or partition. But the little silver wire is so arranged that on passing between the glass and the piston the nerve may be drawn by the hand and so touch the copper. The muscle is immediately seen to contract."

So translated, the passage makes it appear that the muscle was convulsed by the electricity developed through contact of the nerve with the metal, or metals; but the context, and even the passage itself, in another translation, will, I think, show that Swammerdam had no idea of such a thing. Swammerdam's object was merely to irritate the nerve *mechanically*, but not too roughly, and to do so he gently pulled it through the ring, thereby compressing it. Thus, in Thomas Flloyd's translation (1758), we read: "Now, if after this the silver wire be cautiously drawn with a leisurely hand through the ring or eye of the brass wire *till the nerve is irritated by the compression it must by this means undergo*, the muscle will contract itself." The experiment, which is illustrated in the "Biblia Naturæ" and in Flloyd's translation, was performed in a glass cylinder with a simple manometer or pressure gauge to show the contraction of the muscle; and the silver wire was merely an attachment by which the nerve could be drawn into the ring and so mechanically compressed. Swammerdam does not seem to have used either or both metals purposely, and he attributed the convulsion solely to mechanical irritation. He had made many experiments showing that mechanical irritation of the nerve, by a knife or pair of scissors, for example, produced a convulsion in a frog's muscle, and his object in this particular case was to show that the muscle *contracted* instead of enlarging. He doubted the hypothesis of an "animal spirit" flowing from the nerve to the muscle and swelling it, and he shrewdly surmised that no "sensible matter or matter of comprehensible bulk" flowed through the nerve to the muscle. "Nor does anything else pass through the nerves into the muscles" he writes in another part of the "Biblia"; all is a very quick kind of motion, which is indeed so rapid that it may be properly called instantaneous. Therefore, the spirit, as it is called, may with the greatest propriety be compared to the most swift motion which, when one extremity of a long beam or board is struck with the finger, runs with such velocity along the wood that it is perceived almost at the same moment at the other end." He considers such "irritation" (? vibration) to be subtler than the "animal spirits," and that a force is likewise wanting by which that motion (? vibration) is transferred through the nerves into the muscles." The action of the nerve was, in fact, a mystery to him; but it is clear that he had no conception of any electrical effect in his experiments. Swammerdam's intention was to apply a mechanical stimulus, and since that alone could produce the contraction, is it right to assume that electricity did it? Electricity may have entered into the experiment adventitiously, but if we are to give the credit of an electrical discovery to experiments in which electricity might have played an unrecognised part, we shall be able to swell the list of electricians. In justice to Galvani, and in order to check the further propagation of what seems to me a mistake, I should like to draw the attention of physiological electricians to the matter.

Mr. Fahie states that the experiment was made in 1678 before the Grand Duke of Tuscany. In the edition of the "Biblia" which I consulted, that in the British Museum Library, the date is given as 1658, and the experiment shown before the Grand Duke then, was not the one with the silver wire above considered, but the simple convulsion of a frog's muscle by mechanical irritation of the nerve with a pair of scissors.

J. Munro.